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OSSA SPACE STATION WASTE INVENTORY

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OSSA SPACE STATION WASTE INVENTORY

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PREFACE

Prior to selection of actual experiments and investigators for research on Space Station, a critical question needs to be addressed during the current planning phase. What kinds and quantities of waste materials will be generated by the research missions sponsored by the Office of Space Science and Applications (OSSA)? Early identification of the waste materials likely to be generated by research and associated servicing is necessary for designing adequate waste management systems and determining associated operational requirements. Early assignment of resources and program responsiblity for waste management is equally important.

This report contains the best estimates obtainable in the last quarter of 1986 for potential waste generation by 35 missions. These particular missions were selected for study because they are scheduled to become operational early in the Space Station era. The waste estimates were obtained from a large group of OSSA mission planners, managers, technical experts, and related reference documents, and were then compiled in a preliminary waste inventory database. These data are based on the mission plans described in the Mission Requirements Data Base and associated reference payloads. These serve as general guides for future payloads that are to be developed.

The initial waste database should be updated as the OSSA mission descriptions become more accurate. The mission contacts and the contractor support team did, however, make every effort to produce realistic and useful quantitative information at this early date. We think that we succeeded in achieving that objective satisfactorily, primarily because of the interest, cooperation and concern for the importance of the study shown by the various mission contacts. The personal contact between the NASA/contractor team which performed the study at Ames Research Center (ARC) and a knowledgeable OSSA network should be maintained in order to continue this important work beyond the initial results achieved in this preliminary study.

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LIST OF TABLES AND FIGURES

OSSA SPACE STATION WASTE INVENTORY

1.0 INTRODUCTION

1.1 Study Scope and Objectives

The Space Station Planning Group within NASA's Office of Space Science and Applications, which is made up of managers at Headquarters and Goddard Space Flight Center, considers waste management a critical issue. The objective of this OSSA Space Station Waste Inventory study was to acquire the information those planners will need to define preliminary OSSA waste management requirements on the Space Station during its Initial Operational Capability (IOC).

The following guidelines for conducting the study were presented to the OSSA Planning Group and received the group's concurrence:

- o focus on OSSA missions in the Mission Requirements Data Base (MRDB) that are currently defined for the IOC period. (These missions are identified in the MRDB by the prefix SAAX and a number code used as a brief identifier for a particular mission in portions of this report.)
- o utilize the OSSA Space Station Servicing Data Book recently produced by the BDM Corporation as a model for the study report format,
- o coordinate with a concurrent Marshall Space Flight Center (MSFC) Contamination Study through sharing of methodology and data.
- o organize the waste data summaries to reflect a 90-day Space Transportation System (STS) re-supply interval (mission cycle).

1.2 Organization of Report

The remainder of this report consists of seven major sections and five appendices. Section 2 gives a brief summary of previous work reviewed to clarify the conceptual basis of the present study, and identifies links between the present study and some ongoing or recent studies in related areas. Section 3 describes the study methodology. Section 4 summarizes and discusses the study results. A discussion of results is presented in Section 5 to show how some of the study findings relate to waste management aboard Space Station. Section 6 offers some recommendations for future work. These six sections contain all the general information required to understand how the study was done and what information was produced.

The rest of the report provides detailed information, organized to help the reader learn more about a particular sub-area of interest. Section 7 supplements and extends Section 4, by providing brief overviews of each of the IOC missions included in the study and a detailed summary of the types, quantities, and special characteristics of wastes produced by each mission. Appendix A-1 shows and describes the contents of a Request for Information (RFI) form which was the written inquiry sent to data sources, along with a reproduction of the Waste Data Sheet, a worksheet used to consolidate and organize the raw data as it was obtained. Appendix A-2 shows a printout of the entire database in spreadsheet form, along with definitions of its individual elements. Appendix A-3 lists all references, and Appendix A-4 contains a list of the persons who contributed information to the inventory. Appendix A-5 contains a glossary of the acronyms that appear in this report.

2.0 RELATED RESEARCH

2.1 Earlier Waste-related Studies

A literature search was conducted on the subject of Space Station waste generation and management. This search identified several study reports from the early 1970s about waste generation and management (1,2). The reports contained no directly applicable waste data, but did contribute to developing a useful general framework for the present study, and contained concepts applicable to a waste management system design for the current Station.

2.2 Relationship to Recent Studies

2.2.1 Space Station OSSA Contamination Study

A study of contamination assessment for OSSA Space Station IOC payloads was initiated in parallel with this study. The contamination study was monitored at MSFC and performed by Science and Engineering Associates, Inc. (3). The contamination study focused primarily on identifying and quantifying OSSA mission-related contamination (from venting, off-gassing, etc.) in the Space Station external environment, and on modeling of the flow of contaminants from a given location in the external environment to other regions. The managers of both studies conducted informal reviews of each others' progress and methodologies to ensure that the end-products would be complementary.

2.2.2 BDM Servicing Study

The "OSSA Space Station Servicing Data Book" produced by the BDM Corporation in November, 1985 contains data about most of the same missions included in this study (4). The results of the BDM study have been used to develop baseline servicing requirements to guide Space Station Phase B contract studies. For this reason, the report format of this inventory has been partially modeled on the BDM study report. Because servicing is often linked with waste generation, the BDM study report and material from the MRDB were useful to the ARC team in constructing summary profiles of individual missions. Some actual waste data were also included in the BDM study report, and these data were used in the present study as baseline estimates.

The BDM study defined on-orbit servicing to include all aspects of maintenance and repair, while acknowledging that it is difficult to distinguish between operational (experiment- related) procedures and servicing activities, especially in the case of laboratory module missions. This inventory did not make a distinction between servicing and operations in compiling and summarizing data, but such a distinction helped mission experts think about waste production, and the team often discussed servicing waste and operational waste separately while collecting data.

The concept of "service interval", drawn directly from the BDM study, became a basic organizing concept in the waste inventory database. It was applied to data concerning operational as well as servicing waste. How this concept was used is explained in Section 4, "Results."

Other concepts and analytic distinctions used in the BDM study were also directly applicable to the study. For example, BDM divided servicing into two types; planned and contingency. Planned servicing is routine and scheduled, and consists of such tasks as:

- o periodic replenishment of consumables
- o refurbishment (including cleaning, calibration)
- o replacement of degraded systems at known intervals
- o repair of degraded systems at known intervals
- o scheduled replacement of old systems with new systems

Contingency servicing might include many of the same tasks but they would be non-routine and unscheduled. Servicing could also be planned but unscheduled such as when a random but expected failure occurs. Servicing contingencies make waste estimates inaccurate and more difficult to interpret. They complicate waste management planning, because the uncertainty they introduce requires logistic accommodations such as storage of more spare parts on-orbit or storage of an unknown number of failed components until they can be fitted into a return manifest aboard the STS.

Since any servicing task is likely to generate and/or involve handling of some waste materials, waste management probably should incorporate planned and contingency procedures. Contingencies are also associated with experiment operations, and these must be evaluated for their impacts on waste generation and management. Both operational and servicing plans should recognize the possibility of unexpected failures, and make adequate provisions for dealing with such events.

3.0 METHODOLOGY

3.1 Definitions and Assumptions

In this study, waste is defined simply as "an item which is no longer useful in its present form." Usefulness is defined relative only to the orbiting Space Station and there is also a time dimension included in the definition; that is, the item is considered not useful at a given time. The specialists consulted in the study were asked to identify only the waste generated by a specific mission, and therefore the specialist identified waste that is only "no longer useful" to the particular Space Station mission which generates it. These additional considerations are mentioned because they suggest some issues to be confronted in designing a waste management system, which is defined as "hardware, processes and procedures to dispose of waste or transform it into a useful item."

Design of a waste management system should be based on a broad top-down perspective. For example, a waste item may be managed (i.e., become useful) simply by transporting it to another location on the Station where it is needed by some mission other than the one generating it. This option might be overlooked if planning is based on information that does not reflect interactions across disciplines or among missions. A useful overall perspective is outlined in Section 5, "Discussion of Results."

The waste data identified in this study is based on an inventory for the missions that were identified in the OSSA "Yellowbook" (17). The missions labeled as free flyers or attached payloads each consist of a relatively unchanging equipment configuration that will produce waste items of a consistent quantity and composition at periodic intervals. The missions in the pressurized modules will produce waste in a much different manner. The Life Sciences Lab (LSL) and the Microgravity and Materials Processing Facility (MMPF) will each be used to perform a wide variety of experiments using many different types of equipment. There will therefore be unique types and quantities of waste products associated with the thousands of possible experiment/equipment combinations over the lifetime of the Space Station.

Since this early study focuses on the IOC phase of Space Station operations, a "generic" group (scenario) of experiments and facilities identified for IOC by the mission planners was used to produce this inventory. The planners for the LSL are using a scenario from a document known as the "Redbook"(7) at present. The ongoing MMPF study (10) has identified six scenarios. The ARC study team used one of those scenarios that is identified as having "high scientific potential for which the stage of equipment development and present or anticipated funding were considered," since these broad characteristics also describe the Life Science Redbook scenario fairly well.

These scenarios are only representative of many possible alternatives; the actual experiments and equipment in all of the missions will be better defined between now and IOC. Nevertheless, the current scenarios used in this study appear to be sufficiently typical to make waste estimates derived from them useful in planning. Readers of this report can learn about other possible scenarios and/or experiments for the life and materials sciences by reading the "Green"(6) and "Blue" (18) Books, and the MMPF Study (10) respectively.

In summary, this study gathered data intended only to enable preliminary OSSA waste management system requirements to be developed. Additional studies are needed to refine these requirements and develop concepts for handling, processing and disposal facilities for OSSA waste materials.

3.2 Study Methods

The overall work flow for the study is diagrammed in Figure 1. The sequence of activities that made up the study methodology is represented by the boxes in that figure. These activities are briefly described in the following subsections.

3.2.1 Selection of OSSA Missions

The missions included in this study are those used by OSSA in planning for the IOC period of Space Station operations (17). These missions are listed in numerical order in Table 1 and in alphabetical order in Table 2. Table 1 also shows the designated OSSA managers for the various missions, and classifies the missions according to payload type i.e., inside a pressurized lab module, attached externally to the Station structure, or mounted on free-flying platforms. The latter two categories include some missions which are developing multipurpose attached platforms--so-called Hitchhikers--or free flying platforms (Spartan, Explorer) that can serve multiple user needs.

3.2.2 Identification of Waste Data Sources

The study team contacted each designated mission manager as soon as these individuals were identified, and asked that manager to designate a person as primary contact for information about waste produced by the mission. In some cases, the mission manager took this responsibility himself, but in most cases referred the ARC team to a mission specialist. These primary data sources and key reference documents are identified in Section 7, "Mission Waste Profiles and Waste Inventory Forms."

3.2.3 Collection of Data

Each designated data source was sent a Request For Information (RFI) form with

Appendix A-1,"Request for Information Form & Waste Data Sheet ," includes examples of both these documents along with a description of the general method used to identify waste items, sources and quantities. Originally conceived as the components of a mail questionnaire, this combination package became instead an interview guide and basis for structuring respondent inputs.

The ARC team collected data by site visits and interviews because the project leader of the BDM Study, on the basis of his recent experience, strongly recommended that method over a mail questionnaire. As the ARC team learned more about the similarities and differences among the OSSA missions, the greater effectiveness of collecting data through personal interviews became more and more apparent. Experience soon showed that no single, simple format for a mail questionnaire would have served adequately to gather the diversity of data represented by this multidisciplinary group of missions.

Personal meetings were set up and interviews were conducted after the prospective interviewees had had a few days to study the mailed RFI. During the site visits to hold the interviews, the ARC team identified and obtained copies of many valuable background documents. These contained detailed mission descriptions and often provided extensive quantitative data pertaining to potential waste generation. Key documents that were gathered, some unpublished, are listed in Appendix A-3, "References".

3.2.4 Compilation of Data

The waste data were entered into a database, using the Microsoft Excel™ spreadsheet program, on a Macintosh™ computer. Excel™ is a powerful and flexible program capable of generating a wide variety of summary report formats, of which just a few examples are represented by the contents of the inventory forms in Section 7 and by the summary tables and charts in Section 4,"Results." Descriptive information from the MRDB, BDM Study report and other document sources was compiled into brief Mission Waste Profiles as MacWrite™ files on the same computer. The waste database elements are listed and described in Appendix A-2.

3.2.5 Generation of Reports

A Mission Waste Profile, which is a formatted narrative description, was produced for every mission. A Waste Inventory Summary tabulation was also generated for every mission that had quantifiable waste items identified. Each Mission Waste Profile and Waste Inventory Summary form were then sent to the appropriate mission contact for review and approval. Approved versions of these report elements are included in Section 7, "Mission Waste Profiles and Waste Inventory Forms."

FIGURE 1 - WASTE STUDY WORK FLOW

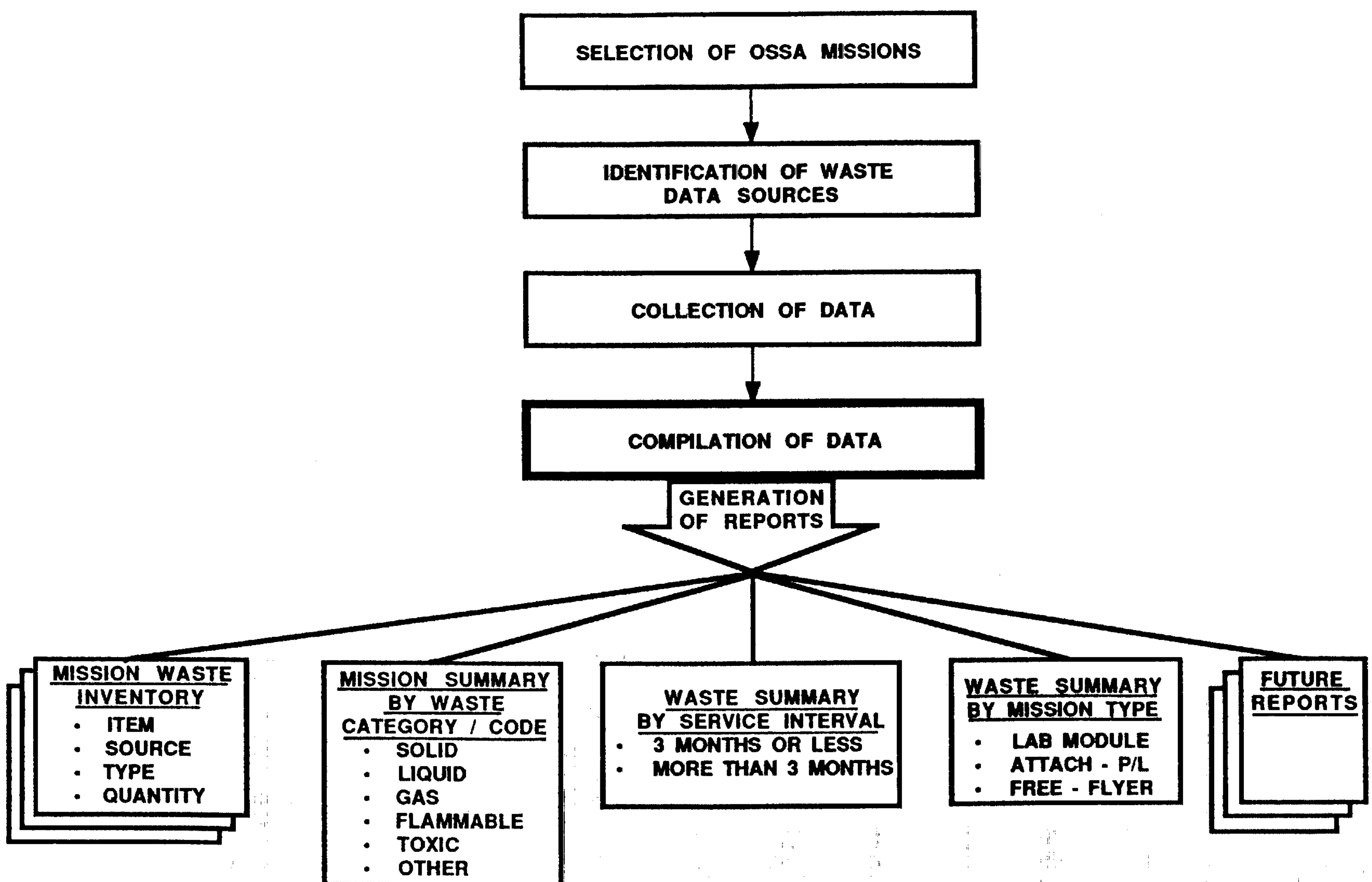

TABLE 1: OSSA Missions and Managers Listed in Numerical Order *

Mission	Acronym	Type **	Code E Manager	Center
SAAX 0001	CRNE	AP	Jon Ormes	GSFC
SAAX 0004	SIRTF	FF	George Newton	HQ
SAAX 0004A	SIRTF Serv.	FF	Edmond Reeves	HQ
SAAX 0010	ASO/HRSO	AP	Edmond Reeves	HQ
SAAX 0010A	ASO/HRSO Serv.	AP	Edmond Reeves	HQ
SAAX 0011	ASO/POF	AP	Edmond Reeves	HQ
SAAX 0011A	ASO/POF Serv.	AP	Edmond Reeves	HQ
SAAX 0012	HST	FF	Jim Welch	HQ
SAAX 0013	GRO	FF	Art Reetz	HQ
SAAX 0017	AXAF	FF	Arthur Fuchs	HQ
SAAX 0017A	AXAF Serv.	FF	Arthur Fuchs	HQ
SAAX 0021	SMF	AP	Jon Ormes	GSFC
SAAX 0022	SSS	FF	Joseph Schulman	GSFC
SAAX 0022A	SSS Serv.	FF	Joseph Schulman	GSFC
SAAX 0027	EX 1	FF	Ken Rosette	GSFC
SAAX 0028	EX 2	FF	William Hibbard	GSFC
SAAX 0029	EX 3	FF	William Hibbard	GSFC
SAAX 0030	HH 1	AP	David Gilman	HQ
SAAX 0031	HH 2	AP	David Gilman	HQ
SAAX 0032	HH 3	AP	David Gilman	HQ
SAAX 0112	CDCE	AP	Bill Roberts	MSFC
SAAX 0115	AT	AP	Bill Roberts	MSFC
SAAX 0207	STO	AP	Bill Roberts	MSFC
SAAX 0207A	ACRIM	AP	Bill Roberts	MSFC
SAAX 0207C	HRTS	AP	Bill Roberts	MSFC
SAAX 0207E	SUSIM	AP	Bill Roberts	MSFC
SAAX 0207F	SEPAC	AP	Bill Roberts	MSFC
SAAX 0207G	WISP	AP	Bill Roberts	MSFC
SAAX 0207H	TEBPP	AP	Bill Roberts	MSFC
SAAX 0207J	RPDP	FF	Bill Roberts	MSFC
SAAX 0250	HH 4 (ERBE)	AP	Robert Schiffer	HQ
SAAX 0251	TRMM	AP	Tom Keating	GSFC
SAAX 0307	LSL	LM	Larry Chambers	HQ
SAAX 0401	MMPF	LM	Donald Wrublik	HQ
SAAX 0502	SBAR	AP	Tom Campbell	HQ

* SAAX numbers are codes used in the MRDB

** LM = Lab Module
AP = Attached Payload
FF = Free-flier/Co-orbiting Platform

TABLE 2: Alphabetical List of OSSA Missions

Active Cavity Radiometer Irradiance Monitor	SAAX 0207A
Advanced Solar Observatory: Pinhole/Occulter Facility Mission	SAAX 0011
Advanced Solar Observatory: Pinhole/Occulter Facility Servicing	SAAX 0011A
Advanced Solar Observatory: Solar Optical Telescope Mission	SAAX 0010
Advanced Solar Observatory: Solar Optical Telescope Servicing	SAAX 0010A
Advanced X-ray Astronomy Facility Mission	SAAX 0017
Advanced X-ray Astronomy Facility Servicing	SAAX 0017A
Astrometric Telescope — Extrasolar	SAAX 0115
Cosmic Dust Collection Experiment	SAAX 0112
Cosmic Ray Nuclei Experiment	SAAX 0001
Explorer 1 (Solar Maximum Mission) Servicing	SAAX 0027
Explorer 2 Servicing	SAAX 0028
Explorer 3 Servicing	SAAX 0029
Gamma Ray Observatory Servicing	SAAX 0013
Hubble Space Telescope Servicing	SAAX 0012
Life Sciences Lab	SAAX 0307
Microgravity and Materials Processing Facility	SAAX 0401
Recoverable Plasma Diagonstic Package	SAAX 0207J
Solar Terrestrial Observatory	SAAX 0207
Solar UV High Resolution Telescope and Spectrograph	SAAX 0207C
Solar UV Spectral Irradiance Monitor	SAAX 0207E
Space-Based Antenna Test Range	SAAX 0502
Space Experiments with Particle Accelerators	SAAX 0207F
Space Infrared Telescope Facility Mission	SAAX 0004
Space Infrared Telescope Facility Servicing	SAAX 0004A
Space Station Hitchhiker 1	SAAX 0030
Space Station Hitchhiker 2	SAAX 0031
Space Station Hitchhiker 3	SAAX 0032
Space Station Hitchhiker 4 (Earth Radiation Budget Experiment)	SAAX 0250
Space Station Spartan Mission	SAAX 0022
Space Station Spartan Servicing	SAAX 0022A
Superconducting Magnet Facility	SAAX 0021
Theoretical and Experimental Beam Plasma Physics	SAAX 0207H
Tropical Rainfall Mapping Mission	SAAX 0251
Waves in Space Plasma	SAAX 0207G

4.0 RESULTS

The study results are presented in this section. The first subsection provides brief general descriptions of the three major payload types, along with examples of the most common classes of consumables (potential waste sources) and wastes for each type. The rest of Section 4 presents and annotates a series of tables and charts that summarize overall waste production by phase, by service interval, by 90-day interval, and by major payload type. Separate tabulations and charts were prepared for mass and volume within each summary category.

4.1 Mission-Based Waste Summary

The capsule descriptions in this sub-section give a sense of a "typical" mission and the major generic types of consumables and wastes associated with three payload types--pressurized lab modules, attached platforms and free-flying platforms. These overviews will provide a concrete context for intepretation of the quantitative data presented in later tables and charts.

4.1.1 Laboratory Module Missions

4.1.1.1 Mission Description - Overview

These missions would be conducted in pressurized, habitable modules with major equipment mounted to the interior. Experiments would be fairly highly automated, but when fully operational would also require daily servicing by the crew. These missions require significant quantities of consumables for their support and continuously produce large quantities of data, samples and waste materials. They would utilize several common hardware items such as workbenches and gloveboxes for materials handling and waste containment. Missions would be supplied with consumables via the logistics module which would also transport equipment change-outs and end-products. Waste would be produced by experiment procedures, maintenance and servicing procedures.

4.1.1.2 Waste Sources/Materials - Overview

The types of consumables which may be waste sources include:

- o life support material (food, water, etc.) for live specimens
- o sample containers and preservatives
- o supplies for housekeeping
- o raw materials for materials processing facilities

The types of waste materials which may be generated include:

- o specimen wastes
- o empty containers, excess preservative
- o housekeeping and experiment procedures wastes
- o materials processing wastes

4.1.2 External Attached Payloads

4.1.2.1 Mission Description - Overview

The external attached payloads are individual or grouped science instrument packages to carry out astronomical/astrophysical or solar-terrestrial experiments and observations. Some of the missions focus on attached science instrument platforms or interfaces, such as the Goddard Hitchhiker variations. These platforms will not be waste producers, although some payloads mounted on them probably will be. A minority of these experiments will have some degree of crew participation, and these intra-vehicular activities (IVA) and procedures will continuously generate a small amount of waste, principally paper. A few missions also anticipate making some on-orbit repairs to failed components which could generate some waste inside the pressurized areas of the Space Station at irregular intervals. Otherwise, waste from these payloads would be generated sporadically from servicing, replenishment of consumables, or changeout of components, including science instruments. This servicing would generally be done as extra-vehicular activity (EVA), often while the STS is docked with the Station; hence the waste produced would not require storage on the Station if it could be returned to Earth on the same STS flight. Changed-out components or empty containers used to bring consumables to orbit are considered waste for purposes of this study, even though they will probably be returned to Earth and recycled.

The types of consumables which may be waste sources are:

- o gases to maintain science instrument environment
- o batteries, fuel
- o film and paper (from Space Station pressurized module when crew are actively involved in science)

The types of waste materials which may be generated include:

- o purged gas from science instruments
- o refueling spillage
- o failed components
- o servicing and data recording waste

4.1.3 Free-flyer/Co-orbiting Platforms

4.1.3.1 Mission Description - Overview

The free-flying and co-orbiting missions include: "mature" scientific instruments packaged with appropriate support equipment, such as the Hubble Space Telescope or the Space Infrared Telescope Facility; conceptual instrument packages in early development stages; and multi-mission spacecraft with or without defined science payloads. The waste associated with these missions would be generated for the most part by infrequent servicing procedures performed while the remote platform is housed in a service bay at the Space Station. Platforms would be retrieved under their own power or by use of an orbital maneuvering vehicle (OMV). After EVA servicing, the platform would be tested near the Station before repositioning it far from the Station. These platforms are generally planned to be self-contained and will either have data recorders on board or will transmit data back to Earth for processing. The Space Station crew would have little to do with day-to-day operations; it is possible, however, that some contingency repairs would be performed on failed components inside the pressurized volume of the Space Station.

4.1.3.2 Waste Sources/Materials - Overview

The types of consumables which may be waste sources on platforms are:

- o gases to maintain science instrument environment (e.g. cryogens for cooling, inert gas)
- o propellants, batteries, recording tapes
- o servicing supplies

The types of waste materials which may be generated include:

- o gas from leakage during recharging
- o servicing waste (scraps of insulation, wire, thermal grease)

4.2 Waste Category/Production Summary

In this section, a summary table shows the amounts (mass, volume) of estimated waste totalled for individual missions by material phase (solid, liquid, or gas) at various service intervals. Overall totals for each interval and phase are also provided. A series of summary charts then depict waste production in each phase by service interval and by successive 90-day intervals for up to 5 years (the longest service interval identified) for each of three payload types--pressurized module, external attached payload, and free-flyers. The charts that use a service interval time-line are based on actual estimates, while those with a time-line divided into 90-day intervals show weighted averages of waste production per interval.

4.2.1 Waste Estimates by Mission Type and Service Interval (Table 3)

Table 3 summarizes the mass and volume of wastes estimated to be generated by each mission for each successive service interval. The service intervals are shown in months, with the mass (kilograms) and volume (liters) totals of solids, liquids and gases for each mission and service interval displayed in separate columns. The total mass and volume for each mission and interval are tabulated in the last two columns.

The very large volumes shown for gaseous waste in the table and charts are based on the use of Standard Temperature and Pressure (STP) as a uniform reporting standard. Other standards (e.g. based on assumed repressurization or liquefication of waste gas) were rejected as being beyond the scope of this study. The following conversion example may help the reader grasp the meaning of these large numbers. If a standard industrial tank of a common gas, such as nitrogen, is brought to STP from a nominal delivery pressure of 3000 psi, the volume of the 1000 liters of compressed gas would increase to 204,000 liters. This conversion ratio of ≈1:200 may be used to interpret the STP volumes reported here.

4.2.2 Total OSSA Mission Waste by Service Interval (Figure 2)

Figure 2 shows the total volume and mass of solids, liquids and gases estimated to be produced during the service intervals shown on the horizontal axis. Wastes are generally produced continuously during the 3 month service interval, since most are attributable to the Life Science Laboratory (LSL) and the Microgravity and Materials Processing Facility (MMPF). Some of the peaks shown for longer service intervals would occur during a brief period at the end of the interval when some servicing activity is being carried out on an external attached payload or on a free-flyer mission. Although one mission (ASO/POF) plans some servicing after 60 months, the types and amounts of waste produced at that interval are not known, so the charts show service intervals only out to 36 months.

4.2.3 Total OSSA Mission Waste Per 90 Day Period (Mass) (Figure 3)

In Figure 3, the mass totals from Figure 2 are redistributed along a horizontal axis on which the intervals represent the nominal Shuttle resupply flight schedule (one flight every 90 days or 3 months). The twenty equal intervals correspond to the 60 months covering all known service intervals--not just the 36 months used in Figure 2. This chart shows cumulative quantities of wastes which are produced in each of the twenty successive intervals. For example, the peak on the SOLID chart Flight #8 (24 months) is the total mass produced from all missions with 3, 6 and 24 month service intervals shown in Figure 2 or Table 3, since these intervals coincide at 24 months. Also, since all quantified LIQUID waste is produced in the lab module on a 90 day cycle, there is no variation among the periods on LIQUID charts.

TABLE 3: WASTE ESTIMATES BY MISSION TYPE AND SERVICE INTERVAL (MONTHS)

Mission Type	Number	SI	SOLID		LIQUID		GAS		TOTAL	
			KG	LTR	KG	LTR	KG	LTR *	KG	LTR
EXT. ATCHED P/L										
	SAAX 0010	3	3.94	6.12	0	0	0	0	3.94	6.12
	SAAX 0010A	12	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	SAAX 0011	3	4.5	6.93	0	0	0	0	4.5	6.93
	SAAX 0011	60	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	SAAX 0021	12	0	0	0	0	275	1.5 mil	275	1.5 mil
	SAAX 0030	6	0	0	0	0	0	0	0	0
	SAAX 0031	6	0	0	0	0	0	0	0	0
	SAAX 0032	6	0	0	0	0	0	0	0	0
	SAAX 0115	24	0	0	0	0	0	0	0	0
	SAAX 0207	36	0	0	0	0	0	0	0	0
	SAAX 0207A	6	0	0	0	0	0	0	0	0
	SAAX 0207C	3	18	27.2	0	0	0	0	18	27.2
	SAAX 0207E	6	0	0	0	0	0	0	0	0
	SAAX 0207F	36	86	381	0	0	0	0	86	381
	SAAX 0207G	N/A	0	0	0	0	0	0	0	0
	SAAX 0207H	N/A	5	27	0	0	0	0	5	27
	SAAX 0207J	6	181	70	0	0	3.2	2240	184.2	2310
	SAAX 0250	6	0	0	0	0	0	0	0	0
	SAAX 0251	36	0	0	0	0	0	0	0	0
FF/CO-ORBITING										
	SAAX 0004	24	2355	7000	0	0	0	0	2355	7000
	SAAX 0004A	24	0	0	0	0	233	1.3 mil	233	1.3 mil
	SAAX 0012	36	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	SAAX 0013	27	0	0	0	0	0	0	0	0
	SAAX 0017	36	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	SAAX 0017A	36	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	SAAX 0022	3	0	0	0	0	0	0	0	0
	SAAX 0022A	3	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	SAAX 0027	24	0.83	4.8	0	0	10	5090	10.8	5095
	SAAX 0028	36	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	SAAX 0029	36	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
LAB MODULE										
	SAAX0307	3	879	3659	799	784	214	85900	1892	90343
	SAAX0401	3	480	2576	2605	2598	365	385000	3450	390174

* Gas volume @ Standard Temperature and Pressure (0 °C and 1 atm.)

4.2.4 Total OSSA Mission Waste Per 90 Day Period (Volume) (Figure 4)

Figure 4 shows volume totals from Figure 2 redistributed along the horizontal axis in the same manner as Figure 3.

4.2.5 Average Waste Mass Per 90 days by Payload Type (Figure 5)

Table 2 and Figures 3 and 4 show that the external attached and free-flyer payload types tend to produce large quantities of waste in peaks at the end of relatively long service intervals. For example, some of the free-flyer payloads may produce a large amount of waste on a 24 or 36 month service interval, but when that large amount is "spread" over several 90 day periods, these payloads account for only a small fraction of the total waste mass per 90 days. On the other hand, the laboratory missions are producing waste continuously, and account for most of the large peaks in the 3 month service interval.

Given this marked disparity between internal and external payloads in their modes of waste production, the raw data were transformed in a way that gives equal "weighting" to the different payload types, relative to the fixed 90 day STS flight schedule. The results of such a transformation are shown in Figure 5. These pie charts depict the average percentages by phase of total waste mass that would be produced every 90 days by the three major types of payloads.

4.2.6 Average Waste Volume Per 90 days by Payload Type (Figure 6)

Figure 6 shows the percentage of the waste volume estimated to be produced per 90 days by the various types of payloads. The volume was averaged as in Figure 5.

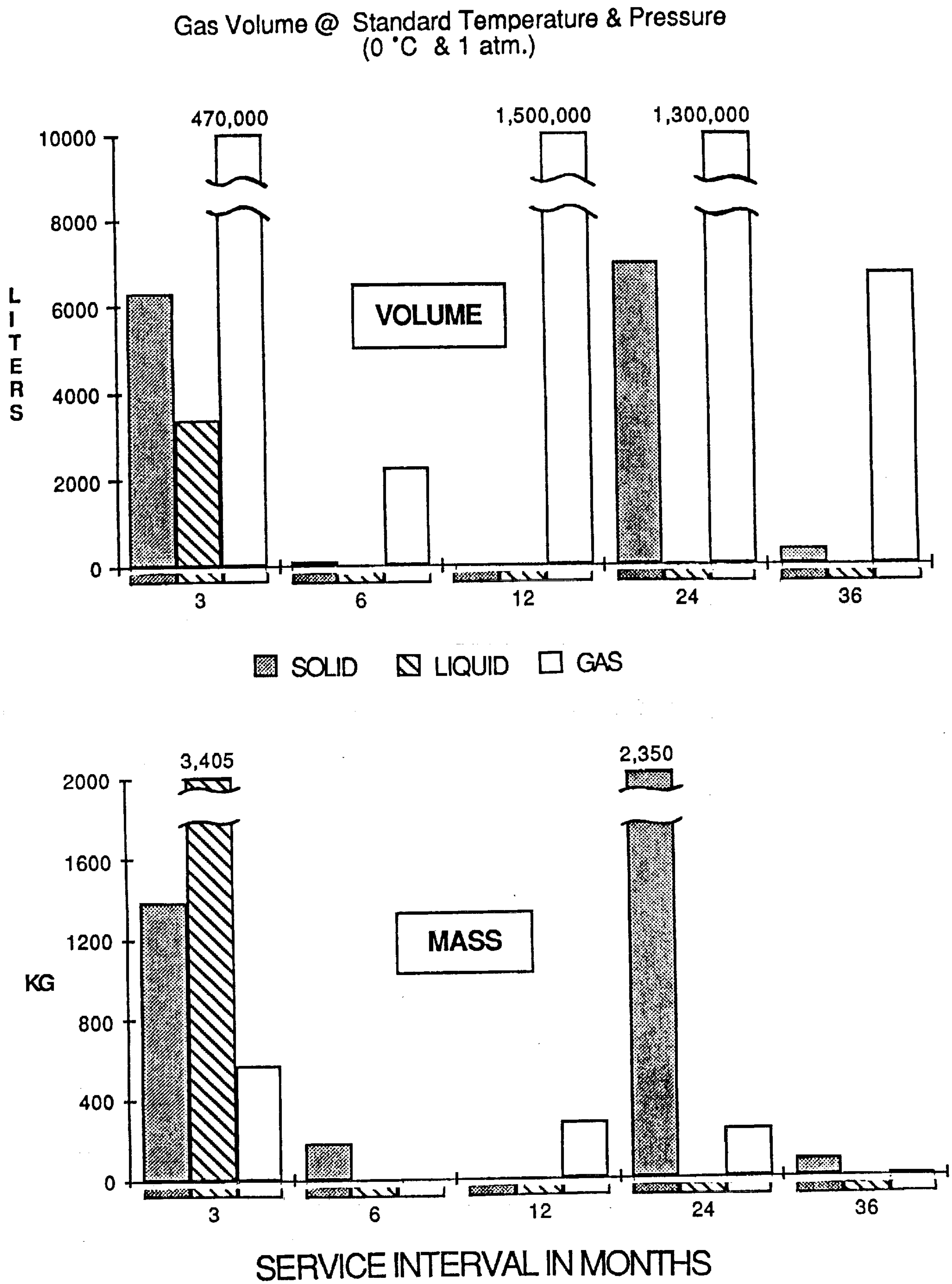

FIGURE 2. TOTAL OSSA MISSION WASTE BY SERVICE INTERVAL

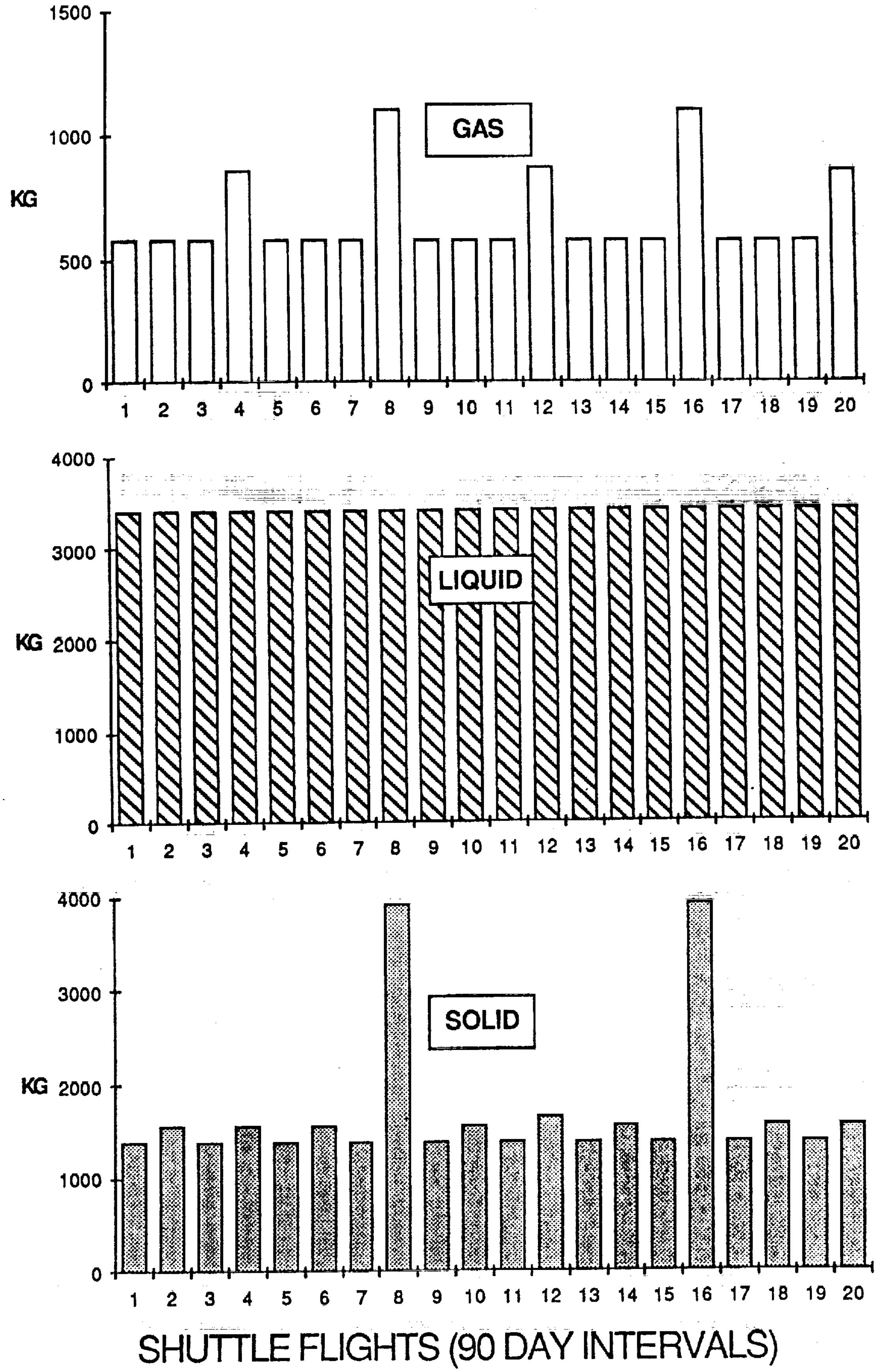

FIGURE 3. TOTAL OSSA MISSION WASTE PER 90 DAY PERIOD (MASS)

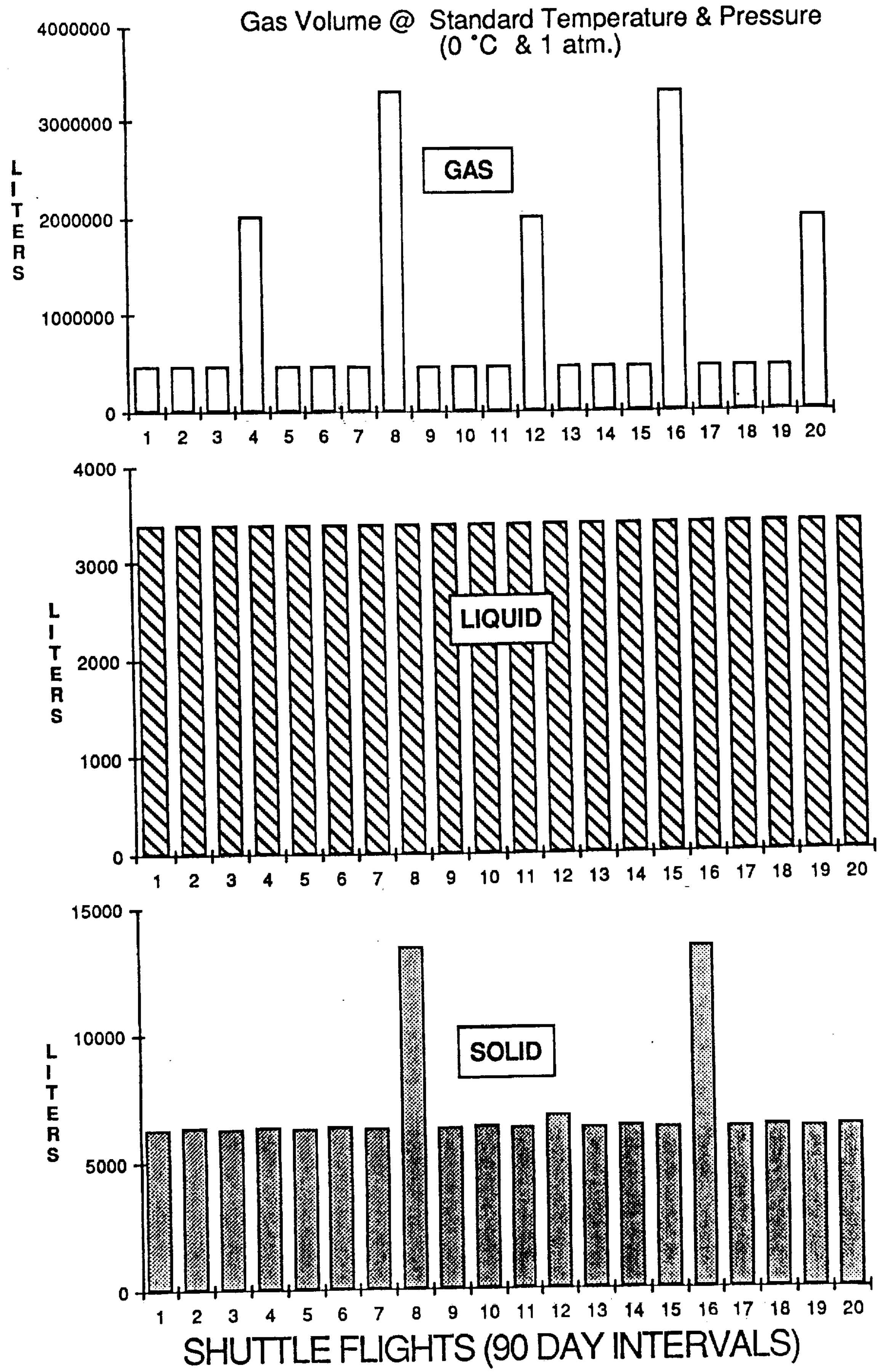

FIGURE 4. TOTAL OSSA MISSION WASTE PER 90 DAY PERIOD (VOLUME)

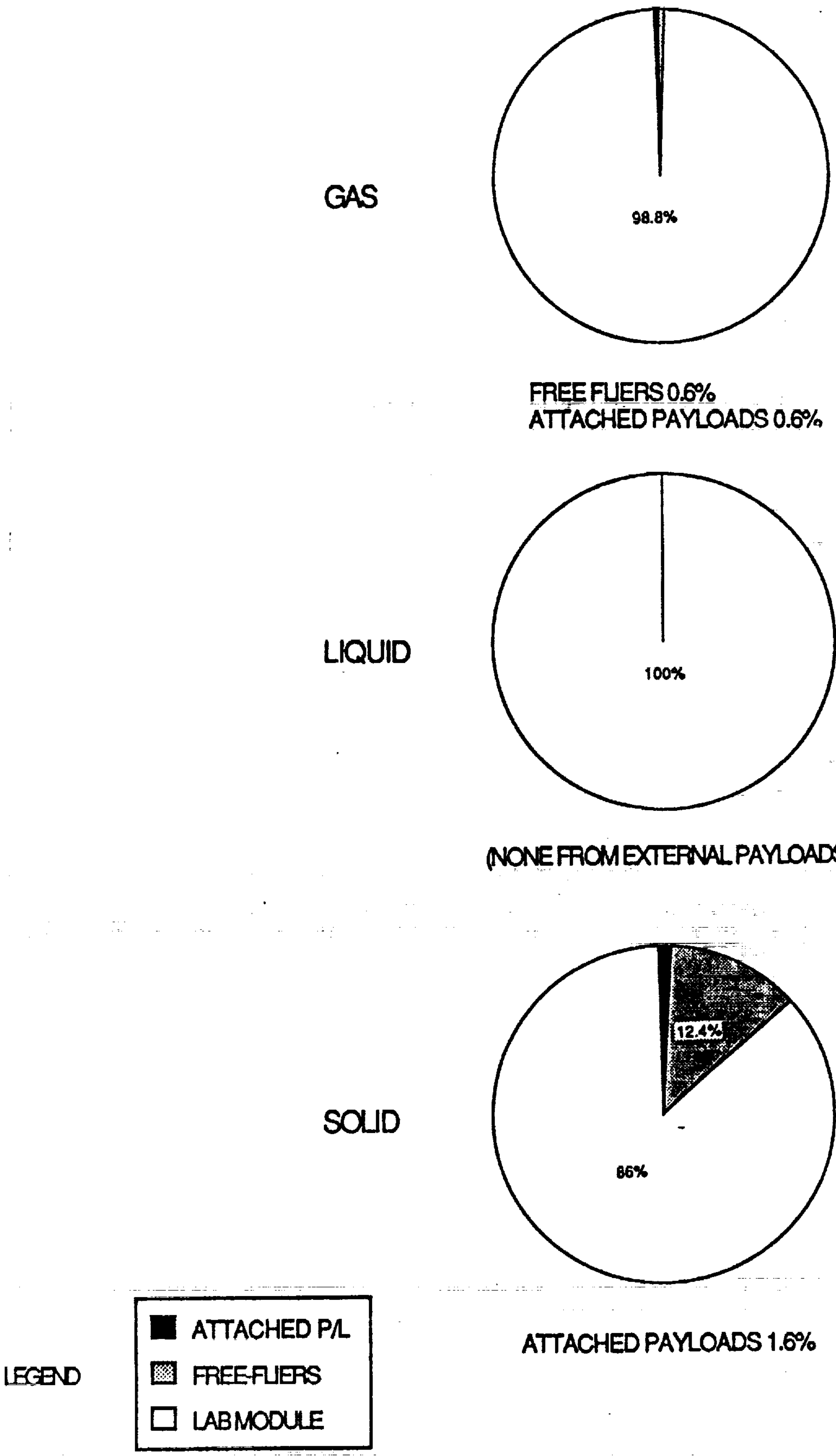

FIGURE 5. AVERAGE WASTE MASS PER 90 DAYS BY PAYLOAD TYPE

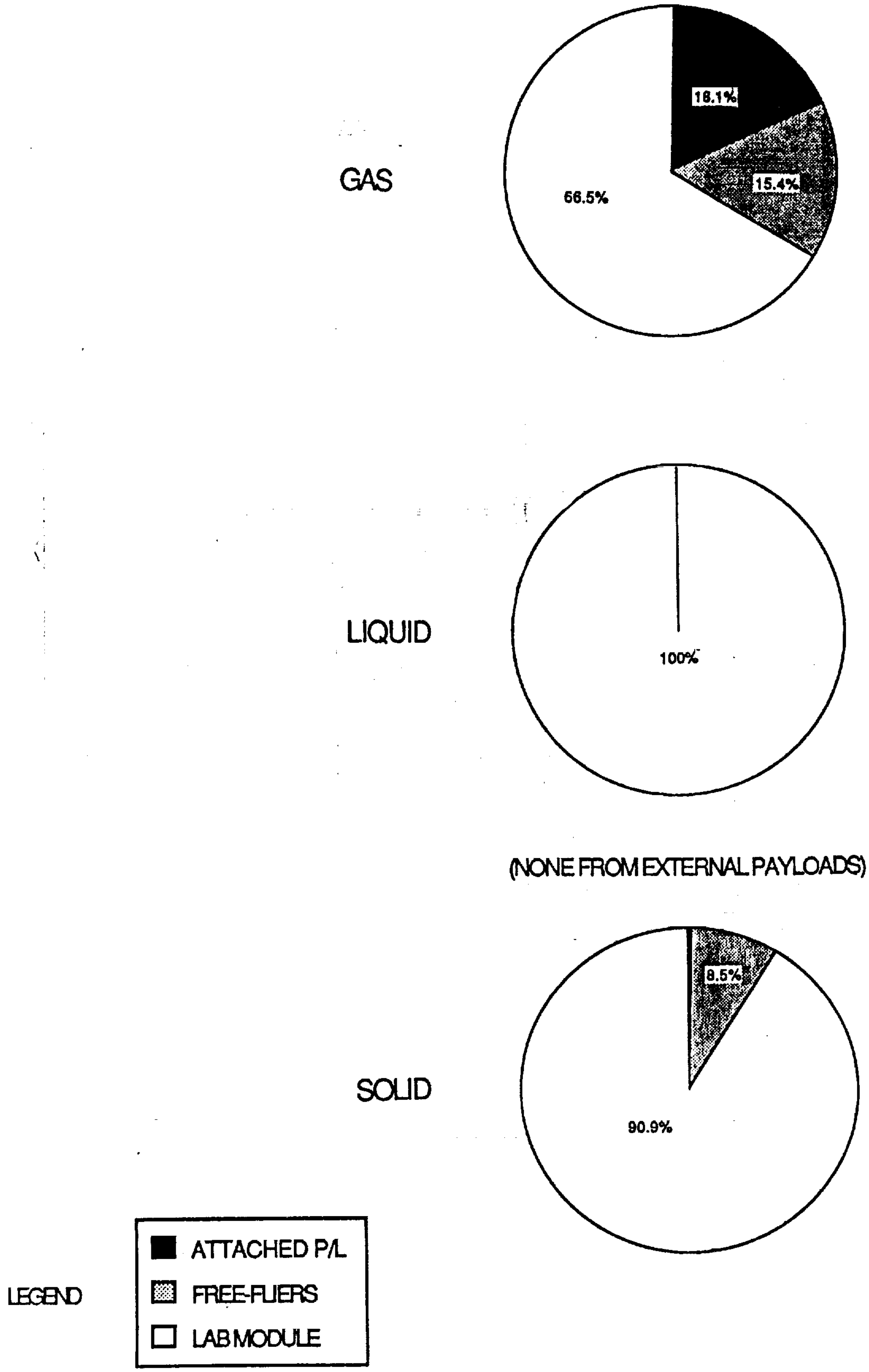

FIGURE 6. AVERAGE WASTE VOLUME PER 90 DAYS BY PAYLOAD TYPE

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5.0 DISCUSSION OF RESULTS

The results of this inventory of waste from OSSA missions support a number of conclusions having important implications for mission plans and schedules.

This report shows that OSSA missions currently included in IOC planning will generate large quantities of waste material and trash. These materials will require handling, processing, and recycling or disposal. Specifically, the IOC missions would generate a total mass of waste material in excess of 5350 kg, or nearly 12000 pounds, during every 90-day nominal interval between STS flights. This figure is about half the permissible landing weight for the STS, currently set at roughly 24000 pounds. The assumption that the crew habitation module and the European and Japanese modules will generate at least an equal quantity of waste and trash seems conservative. If that assumption holds, however, then the OSSA data suggest that the STS would be virtually dedicated to returning wastes unless on-orbit waste processing, reuse/recycling, and other alternatives to STS de-orbiting are planned.

Current plans recognize that such common, high volume commodities as water and atmospheric gases should be reclaimed and reused aboard Space Station. This study gives OSSA planners quantitative information that will allow them to identify opportunities to reclaim and reuse other waste products from science missions, such as purge gases, solvents, and cleaning fluids other than water. In many cases, large quantities of raw materials will be converted into relatively clean waste by the original users. These users may discover that in the long run it is advantageous to process this waste on orbit and reuse it, rather than discarding and replacing it. Even if the original users do not opt for recycling, some other use for the processed material may be found elsewhere aboard the Space Station. If so, adequate processing and transfer of reusable materials must be planned, including guidelines for sharing the costs and benefits of such exchanges among OSSA missions or with other Space Station program areas.

The individual OSSA mission plans on which the missions specialists based their quantitative estimates for this study are incomplete and not fully integrated into an overall Space Station growth plan. The estimates given for several of the missions are based on complex "strawman" payload scenarios that will undoubtedly change. This makes the data difficult to relate to IOC constraints in such critical areas as Space Station volume and power, or STS capacity and flight scheduling. Interpretation and use of the data presented here must recognize these facts. Also, while the missions studied make up a planning envelope for the IOC time frame, it is unlikely that all of these missions will ever be fully operational at the same time. Despite these limitations to the realism of the estimates presented in this report, they constitute the best information available on which to base design requirements. They are valid and accurate within the limits of the assumptions and guidelines for interpretation that have been clearly stated throughout the report or

22

which are included in the database "Notes" in Appendix A-2. Equally important, perhaps, the data can be improved by using the approach that was tested and validated in this study.

Each disciplinary set of OSSA missions has been planned in relative isolation from others and from other Space Station user groups. The variety and quantity of materials that will be available in the total OSSA waste pool for recycling was not known until this study inventoried them. The resulting database of program-wide information will make it possible to plan more efficient management of these materials across scientific disciplines, and ultimately across boundaries of other Space Station functional areas.

Waste management can be thought of as encompassing four sequential phases:

Waste Generation (source, type, rate)
Waste Handling (containment, transfer)
Waste Processing (treatment, processing, utilization)
Waste Disposal (stowage, disposal)

These steps are common to both Earth and space-based waste management. The fact that the Earth is a relatively closed ecosystem is having an increasing impact on the operations of modern societies. Similarly, the "permanent" Space Station will inevitably function as a relatively closed artificial ecosystem. Skylab provided the U.S. a major flight opportunity to develop preliminary experience in virtually all of these waste management areas (5), experience which showed that waste management will be extremely important to Space Station designers. This study clearly focused on the waste generation step. The next logical task is to apply the information generated in the present study to solving problems connected with waste handling, processing, and disposal.

It appears that the initial Space Station configuration will be scaled down from previous versions, and that OSSA will have to compete aggressively with commercial, technology development and military missions for space on STS flights and for scarce Space Station resources at IOC. These developments make it imperative that OSSA mission operations and servicing plans provide for an efficient materials management process to address the major waste management problems brought to light by this study. In light of the quantities of waste the OSSA missions would produce, the option of using the STS to return these materials to Earth is clearly not desirable or perhaps even viable if any significant science goals are to be achieved during IOC.

6.0 RECOMMENDATIONS

This study developed a waste materials database that can support much more realistic waste management planning, but its adequacy as a planning tool can only be tested by using it. The sooner it is put to that test the better, so that waste management can be given the critical attention it deserves in an overall materials management plan. The present study should be continued, and its scope widened to include both data collection and use of the data to generate specific requirements and design concepts for a waste management system to serve OSSA and the other users aboard Space Station. This next phase should be initiated with minimum delay for two major reasons.

1) There is widespread interest in addressing waste management problems effectively among OSSA mission managers and payload specialists who participated in this study. Continuing the present work will sustain and mobilize this interest to bring about effective, cooperative waste management planning. This planning is presently not keeping pace with such related developments as the issuance of the Phase C/D Space Station RFP. Unless materials management is given continuing attention, Space Station design decisions will be made without adequate inputs on waste management issues, to every user's detriment.

2) The inventory just completed and summarized in this report represents only a partial--although substantial--accounting of waste material production. Many, if not most, OSSA Space Station mission plans are in rapid flux, and additional planning decisions are being made almost daily that will change <u>and often add to</u> the total quantity of prospective waste. During this initial inventory phase, the ARC team became thoroughly familiar with the status of OSSA mission plans as they stood in mid-1986, and made strong links to a network of extremely knowledgeable OSSA mission experts. These engineers and scientists are now aware of and thinking about waste management problems. A follow-on phase of work on this problem will sustain the momentum established during the first phase, and increase the cost-effectiveness of the effort already invested. It will enable the existing inventory to be updated without loss of continuity, and insure that changes or additions can be related to the results of this study. Constantly improving information about waste will give mission planners an incentive to continue to work the waste management problem at a program-wide level as well as within each science discipline and each mission's particular context. Without continuity of effort, the existing database will rapidly be outdated and will, of course, remain incomplete.

Specific next steps recommended are:

1. Continue to collect waste data, to fill in gaps and improve the overall quality of the waste materials inventory that was developed in the present study. Establish a dissemination procedure to make periodic updates of the database and special reports derived from the database available to members of the OSSA mission development community.

2. Develop preliminary requirements for OSSA waste management system design, examine alternative approaches to Space Station waste management relative to these requirements, and relate these approaches to waste management planning in other areas, such as crew habitat and non-OSSA programs (commercial and technology development).

3. Develop a conceptual design for an integrated waste management system or facility to serve OSSA needs aboard the Space Station at a minimum, while providing for post-IOC growth and also for integration with Station-wide waste management concepts.

The objective of this study was to perform a detailed and quantitative inventory of the waste which the OSSA missions within the IOC planning envelope will produce. This inventory was completed as planned, within limits imposed by the current uncertainties in OSSA mission plans. The information has been organized in a computer database and is ready for OSSA planners and others to use in defining waste-related requirements for a Space Station materials management system. A copy of the Macintosh computer disk is available from the Study Manager.

7.0 MISSION WASTE PROFILES AND WASTE INVENTORY FORMS

7.1 Mission Profile Outline Description

A Mission Waste Profile is presented for each mission in sections 7.3, 7.4 and 7.5, classified by type of payload. Missions for which quantified waste was available include an attached Waste Inventory Form explained in section 7.2. Missions are presented in numeric order within sections, for ease of location.

Each Mission Waste Profile includes the following major headings:

MISSION CONTACT - Mission contacts are listed with their associated institutions. The contact who served as the primary mission data source and mission Waste Profile reviewer is designated by a [*]. Full addresses for all contributors are given in Appendix A-4.

MISSION DESCRIPTION - A short mission description is given which was compiled from either the MRDB or documents supplied by the mission contacts.

OPERATIONAL LIFETIME - The estimated operational lifetime of the mission hardware after on-orbit placement. At the end of this period the hardware might require major refurbishment on the ground in order to be considered for redeployment. Data sources were similar to that for Mission Description above.

SERVICING/MAINTENANCE INTERVAL - Estimated duration(s) of time between planned on-orbit servicing. Data sources similar to that for Mission Description with updating by mission contacts.

SERVICING SCENARIOS -

> EVA (extra-vehicular activity) - Major servicing tasks (and candidate waste items) conducted outside the Space Station or STS.
>
> IVA (intra-vehicular activity) - Same as EVA but for inside the Space Station or STS.

COMMON HARDWARE - Mission-related hardware items that were not experiment-specific such as a multi-purpose workbench, glove box, or generic experiment support facilities. These hardware items are frequently associated with the generation and containment of waste.

EXPERIMENT PAYLOADS - Experiment hardware which can be attached to or used in conjunction with the Common Hardware described above. These hardware items were frequently associated with the generation, but not necessarily containment, of waste.

CONSUMABLES - Mission-related supplies which would be "consumed" on-orbit during experiment-related and servicing-related tasks. These items would be prime candidates for generation of waste. Some waste which originated as a consumable item may be processed on-orbit or on the ground into a new consumable. Water would be a prime candidate for this procedure.

LIMITED LIFE PARTS - Components of the mission-related hardware discussed above which either have known lifetimes and must be replaced prior to their failure during planned servicing or have highly variable lifetimes and are replaced upon failure during contingency servicing. Some of these parts can be viewed as planned or contingency waste items. Others may require failure analysis and be returned to usefulness or disposed of on-orbit or on the ground.

WASTE ITEMS - These items were identified during analysis of the above areas or were already known as wastes and could be quantified on the Waste Inventory form attached to the mission Waste Profile form.

COMMENTS - Background information helpful for interpreting the mission profile or waste data.

REFERENCES - The major references used to develop each Waste Profile are listed below. The abbreviated title given is used to identify the reference in this section for each mission. The number given is its number in Appendix A-3, "References."

4) BDM Study
6) ARC Greenbook
7) OSSA Redbook
8) MRDB
9) Space Station Mission Data Waste Management Requirements Assessment
10) MMPF Study
11) Richard Williams Report
12) TRW Payload Database
13) GSFC Miniworkshop Report
14) SAIC Operational Scenario for STO
15) TRMM memo
16) Lane et al. Study

7.2 Waste Inventory Form Description

Waste Inventory Forms for each mission were produced by abstracting essential data from the computer database. The total array of elements in this database is described in Appendix A-2. Waste Inventory Forms were generated for all missions with quantifiable waste items. Each of the column headings in the Form is explained below.

The **Hardware** column in the form was used to define a specific hardware item which was a source of waste. The **Procedure** column was used to define a specific task or procedure (if pertinent) which generated or produced the waste. Most missions did not call for use of this column.

The **Waste Item** column contains labels for distinguishable kinds of waste at the lowest level of description. Each Waste Item row was given a unique Identification Number **(ID#)** in the database, to allow items to be uniquely referred to, and to permit restoration of the original ordering after database sorting to produce a special report.

The **Unit** column provides an objective way of dividing waste into unitary amounts. Some typical Units are one battery, the amount of gas leakage per recharge of a vessel, or the amount of water used to clean a piece of apparatus after an experiment. These units were essential for the computation of waste production rates; they are relatively uninformative taken by themselves, however. In most cases, this unit was created during the data entry phase. For mission SAAX 0401, the Microgravity and Materials Processing Facility, the Unit designation is"1 run" which is the amount of waste produced during a specific processing experiment cycle.

The Service Interval **(SI)** is listed for each Procedure/Waste Item in the Waste Summary Form in months. Mission service intervals were obtained from various sources and varied from 3 to 36 months. In the case of missions designed for the pressurized modules where servicing could occur on a daily basis, the SI was still listed as 3 months since more detailed data was not available at the time of this Study and the focus was on 3 month waste totals.

The column labelled **#/SI**, is the number of Units produced per Service Interval. This waste is not necessarily only related to servicing procedures, but includes all waste produced during a given SI. For some waste items the number entered is "1" to indicate that the waste item is generated continuously over time e.g., a gaseous waste.

The column labelled **kg/SI** in the Waste Inventory Form is the mass of the waste Unit (in kilograms), multiplied by the number of Units generated per servicing interval. When the mass of a waste item was estimated as a range, an average is used for any computations. The raw data for Mass/Unit is not shown in the summary table but is an element in the database shown in Appendix A-2.

The column labelled **ltr/SI** in the Waste Inventory Form provides estimates of volume of the waste items in liters. Where mass only was provided for a waste item, the volume was computed based on density values for the material. Volume of gases was uniformly adjusted to Standard Temperature and Pressure (STP).

The **Phase** column was used to classify waste items into material categories or phases of solid (S), liquid (L) and gas (G). The **Code** column allowed each item to be qualitatively coded in a variety of ways, to support production of special reports. The codes used included: **B**=bioactive; **C**=corrosive; **F**=flammable; **R**=radioactive; S=sharp; and **T**=toxic. Obviously, these codes will be important when future waste handling, containerization, processing, transport, and disposal issues are addressed.

7.3 Laboratory Module Missions

7.3.1 SAAX 0307 — Life Sciences Lab (LSL)

MISSION CONTACT(S): Gary Primeaux (JSC), LaDonna Miller (JSC — MATSCO), Caye Johnson (ARC)*, Steve Corbin (ARC — MATSCO)

MISSION DESCRIPTION: The LSL is located in a pressurized module. It will support conduct of a full spectrum of life science research using humans, animals and plants as subjects. With the addition of an animal and plant vivarium and lab module (SAAX 0302) post-IOC, the LSL may convert to a human research lab (SAAX 0303). The LSL will be outfitted with animal and plant life support and growth facilities, specimen maintenance systems, physiological monitoring instruments, stowage, a workbench, freezers, data collection and management systems.

OPERATIONAL LIFETIME: TBD

SERVICING/MAINTENANCE INTERVAL: Minor daily, major each 90 days.

SERVICING SCENARIOS:

EVA: None identified.

IVA: Specimen maintenance, biosample acquisition, on-board sample processing, laboratory maintenance, and cleaning will all produce waste.

COMMON HARDWARE: See following table.

EXPERIMENT PAYLOADS: Reference payload from Greenbook and Redbook (see References below).

CONSUMABLES: See following table.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: See following table.

COMMENTS: Contingency servicing may be necessary to support animal specimen welfare if vivarium has major failure. Logistics module might serve as backup animal life support system, or subjects may be humanely euthanized within the enclosed workbench.

REFERENCES: ARC SLA Greenbook, OSSA Redbook, BDM study, MRDB, Space Station Mission Data Waste Management Requirements Assessment (July 1, 1986)

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
63	Multi-purp. work bnch		filters	filter	3	12	10.8	137.6	S	B
64	Multi-purp. work bnch		trace contaminant	trace	3	2	45.4	121	G	T
65	Multi-purp. work bnch		vent cannister	cannister	3	2	4.6	10	S	B
66	Multi-purp. work bnch		absorbant pads	pad	3	12	2.724	3.684	S	B
67	Multi-purp. work bnch		specimen	specimen	3	30	0	0	S	B
68	Habitat		waste tray	tray	3	216	194.4	432	S	B
69	Habitat		urine collector	collector	3	12	12	11.76	S	B
70	Habitat		filters w/ charcoal	filter	3	2	10.9	16	S	B,T
71	Habitat		feces	2 rat/week	3	216	21.2	0	S	B
72	Habitat		urine	36 rat/week	3	12	49.6	49.6	L	B
73	Habitat		evap. water	36 rat/day	3	12	77.76	77.76	L	
74	Habitat		spent nutrient		3	1	40	40	L	B
75	Centrifuge		waste tray	tray	3	96	86.4	192	S	B
76	Centrifuge		urine collector	collector	3	12	12	11.76	S	B
77	Centrifuge		filters w/ charcoal	filter	3	2	10.9	16	S	B
78	Centrifuge		feces	2 rat/week	3	96	9.41	0	S	B
79	Centrifuge		urine	16 rat/week	3	12	22	22	L	B
80	Centrifuge		evap. water	16 rat/day	3	12	34.6	34.6	L	
81	Cage washer		water	cage wash	3	1	41	41	L	B
82	Cage washer		detergent	cage wash	3	624	15	20	L	B
83	Cage washer		filters	cage wash	3	13	3	50	S	B
84	rodent		rodent	specimen	3	52	0	0	S	
85	plant		plant	plant	3	50	0	0	S	
86	habitat module		habitat module	module	3	18	300	1000	S	
87	gloves		gloves	box of 50	3	5	2.5	12	S	B
88	gowns		gowns	box of 25	3	5	15	50	S	B
89	masks		masks	box of 25	3	5	0.5	10	S	B
90	wipes, dry		wipes, dry	box	3	20	2	10	S	B
91	wipes, wet		wipes, wet	box	3	20	2	30	S	B
92	rodent food		rodent food	1 rat/day	3		28	56	S	
93	rodent water		rodent water	1 rat/day	3		44.9	44.9	L	
94	rodent oxygen		rodent oxygen	1 rat/day	3		0	0	G	

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
95	rodent carbon dioxide		rodent carbon dioxide	1 rat/day	3		168.5	85800	G	
96	plant water		plant water		3		400	400	L	B
97	plant nutrients (dry)		plant nutrients (dry)		3		0	0	S	
98	plant oxygen cylinder		empty cylinder		3	1	5	2.7	S	
99	plant carb diox cylinder		empty cylinder		3	1	5	2.7	S	
100	syringes, 12 ml		syringes, 12 ml	syringe	3	80	0.8	5	S	B
101	needles, 20G, 1"		needles, 20G, 1"	needle	3	200	0.3	4	S	B
102	ammonium heparin		ammonium heparin	ml	3	100	0.1	0.1	L	B
103	centrifuge tubes, 5 ml		centrifuge tubes, 5 ml	tubes	3	200	0.1	5	S	B
104	syringes, 1 ml		syringes, 1 ml	syringe	3	24	0.01	1	S	B
105	parafilm, 4" wide		parafilm, 4" wide	roll	3	1	0.4	2	S	B
106	microhematocrit tubes		microhematocrit tubes	tube	3	500	0.002	0.5	S	B
107	mini-capil tube sealant		capillary tube sealant	tube	3	2	TBD	TBD	S	
108	tube, 10 ml		tube, 10 ml	tube	3	250	3.2	10	S	B
109	syringes, 2 ml		syringes, 2 ml	syringe	3	200	1.6	4	S	B
110	gloves		gloves	box of 50	3	5	2.5	12	S	B
111	gowns		gowns	box of 25	3	5	15	50	S	B
112	masks		masks	box of 25	3	5	0.5	10	S	B
113	petri dish, 60 mm dia.		petri dish, 60 mm dia.	dish	3	180	1.2	10	S	B
114	petri dish, 100 mm dia.		petri dish, 100 mm dia.	dish	3	180	3.6	30	S	B
115	beaker, 50 ml		beaker, 50 ml	beaker	3	180	1.5	10	S	B
116	weigh boat, 3 1/16" sq.		weigh boat, 3 1/16" sq.	boat	3	400	0.8	3	S	B
117	saline solution		saline solution	ml	3	2000	2	2	L	B
118	anaesthetic		anaesthetic	25 cc	3	1	TBD	TBD	L	
119	serum tubes		serum tubes	30 ml	3	40	1.6	4	S	
120	containers (anml. tissue)		containers-anml. tissue	container	3	300	9.9	40	S	
121	fixative, animal		fixative, animal	ml	3	15000	15	TBD	L	
122	containers (plant tissue)		containers-plant tissue	container	3	35	1.24	15	S	
123	fixative, plant		fixative, plant	ml	3	5650	5.6	TBD	L	
124	plastic bags, small		plastic bags, small	bag	3	1000	3	11	S	
125	plastic bags, large		plastic bags, large	bag	3	400	9	30	S	
126	vials, spent nutnt, 10 ml		10ml.vials, spent nutnt	vial	3	448	4	30	S	

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
127	perfusion fluid		perfusion fluid	ml	3	300	0.3	1	L	B
128	film		film	TBD	3	TBD	3.5	31	S	
129	Blood Collection Kit	Blood Draws	syringes	syringe	3	144	0.032	1.44	S	B
130	Blood Collection Kit	Blood Draws	blood collection tubes	tube	3	57.6	0.013	0.374	S	B
131	Blood Collection Kit	Blood Draws	alcohol pads	pad	3	144	0.073	0.432	S	B,F
132	Blood Collection Kit	Blood Draws	reagent volume		3	57.6	12.5	12.5	L	T
133	Blood Collection Kit	Blood Draws	general supplies		3	144	1.8	18	S	B
134	Blood Collection Kit	Blood Draws	needles	needle	3	144	0.032	0.936	S	S
135	Blood Collection Kit	Blood Draws	container	container	3	1	8.1	27.5	S	
136	Echocardiograph	Echo	Echo gel		3	78	0.819	1.014	L	
137	Echocardiograph	Echo	wet wipes	wipe	3	468	0.48	15.21	S	B,F
138	Echocardiograph	Echo	dry wipes	wipe	3	468	0.236	15.21	S	B,F
139	Electrode Kit	Electrodes	electrodes	pair	3	108	0.594	3.24	S	B
140	Electrode Kit	Electrodes	dry wipes	wipe	3	108	0.055	3.51	S	B,F
141	Electrode Kit	Electrodes	alcohol pads	pad	3	108	0.111	3.51	S	B,F
142	Electrode Kit	Electrodes	wet wipes	wipe	3	108	0.111	3.51	S	B,F
143	Electrode Kit	Electrodes	container	container	3	1	4.5	17.5	S	
144	Exercise Equipment	Exercise	electrodes	pair	3	702	7.371	21.06	S	B,F
145	Exercise Equipment	Exercise	dry wipes	wipe	3	936	0.473	30.42	S	B,F
146	Exercise Equipment	Exercise	wet wipes	wipe	3	936	0.959	30.42	S	B,F
147	Microbiologic Lab Cultures	Mic-biologic cul.	vials	vial	3	78	1.989	1.989	S	B
148	Microbiologic Lab Cultures	Mic-biologic cul.	reagent volume		3	78	12.5	12.5	L	B,T
149	Microbiologic Lab Cultures	Mic-biologic cul.	general supplies		3	78	2.34	15.6	S	B
150	RIA Hardware	RIA's	vials	vial	3	18	0.144	0.225	S	B,R
151	RIA Hardware	RIA's	syringes	syringe	3	18	0.005	0.225	S	B,R
152	RIA Hardware	RIA's	reagent volume		3	18	0.495	0.495	L	B,R,T
153	RIA Hardware	RIA's	general supplies		3	18	0.54	2.34	S	B,R
154	Urine Collection System	Sampling	dry wipes	wipe	3	540	0.273	17.55	S	B,F
155	Urine Collection System	Sampling	incontinence bags	bag	3	540	0.554	21.6	S	B
156	Urine Collection System	Sampling	reagent volume		3	540	12.5	12.5	L	T
157	Urine Collection System	Sampling	general supplies		3	540	18.9	432	S	B
158	Urine Collection System	Sampling	wet wipes	wipe	3	540	0.554	17.55	S	B,F

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
159	Feces Collection System	Sampling	dry wipes	wipe	3	540	0.273	17.55	S	B,F
160	Feces Collection System	Sampling	bolus cups	cup	3	540	1.62	94.5	S	B
161	Feces Collection System	Sampling	cup lids	lid	3	540	0.273	6.75	S	B
162	Feces Collection System	Sampling	reagent volume		3	540	12.5	12.5	L	T
163	Feces Collection System	Sampling	general supplies		3	540	18.9	432	S	B
164	Feces Collection System	Sampling	wet wipes	wipe	3	540	0.554	17.55	S	B,F
165	Containers		containers	container	3	1	5	17.5	S	

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7.3 Laboratory Module Missions

7.3.2 SAAX 0401 — Microgravity and Materials Processing Facility (MMPF)

MISSION CONTACT(S): Donald Wrublik (HQ), Charles Baugher (MSFC), Danny Xenofos (MSFC), Wheeler Vann (Teledyne-Brown Engineering)*.

MISSION DESCRIPTION: The MMPF is housed in a pressurized laboratory module. The baseline configuration calls for approximately 26 double equipment racks. For the purposes of this study, a mission scenario which emphasizes science experiments, using current technology, is followed in generating waste estimates. This equipment consists of the experimental facilities and support equipment plus characterization equipment. This scenario assumes 24 hr/day manned operation of the MMPF; the equipment utilization rate ranges from 2% to 100%.

OPERATIONAL LIFETIME: TBD

SERVICING/MAINTENANCE INTERVAL: Replenishment from logistics module every month; reconfiguration of facilities as often as every 6 months.

SERVICING SCENARIOS:

> EVA: None identified for SAAX 0401. Proposed attached payload associated with MMPF (SAAX 0402) is not considered in this study.
>
> IVA: Servicing is defined as including consumables resupply, equipment changeout, and equipment repair outside the MMPF. Fresh raw materials will be brought to the MMPF by the STS as frequently as possible, and sample products and waste will be returned to earth on the return flight. Equipment changeout (whole or partial pre-configured racks) may occur every 3 months.

COMMON HARDWARE: See following table.

EXPERIMENT PAYLOADS: Scientific experiments are TBD; current estimates are based on Scientific Payload Scenario from MMPF Study.

CONSUMABLES: See following table.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: See following table.

COMMENTS:

REFERENCES: MRDB, BDM Study, MMPF Study (June 30, 1986).

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
166	Acoustic Levitator		xenon	1 run	3	4	9.6	1640	G	
167	Acoustic Levitator		water	1 run	3	4	8	8	L	T
168	Acoustic Levitator		boule fragments	1 run	3	4	0.4	0.24	S	
169	Acoustic Levitator		cleaning fluids	1 run	3	4	8	8	L	T
170	Acoustic Levitator		cooling fluids (He)	1 run	3	4	0.016	88	G	
171	Acoustic Levitator		wipes	1 run	3	40	0.02	1.3	S	T
172	Acoustic Levitator		gloves	pair	3	8	0.16	0.8	S	T
173	Acoustic Levitator		saw blades	blade	3	8	TBD	TBD	S	
174	Acoustic Levitator		melt vapors	1 run	3	4	0.1	0.02	G	T
175	Glovebox		nitrogen	1 run	3	16	3.04	2400	G	
176	Alloy Solidification		cleaning fluids	1 run	3	3	9.9	9.9	L	T
177	Alloy Solidification		cryofluid	1 run	3	3	10.2	7750	G	
178	Alloy Solidification		selected gases	1 run	3	3	1.5	840	G	
179	Alloy Solidification		ampoule fragments	1 run	3	3	1.71	0.66	S	
180	Alloy Solidification		metal particles	1 run	3	3	1.2	0.21	S	T
181	Alloy Solidification		wipes	wipe	3	30	0.015	0.975	S	
182	Alloy Solidification		gloves	pair	3	6	0.12	0.6	S	
183	Alloy Solidification		saw blades	blade	3	12	TBD	TBD	S	
184	Alloy Solidification		water	1 run	3	3	24	24	L	
185	Glovebox		nitrogen	1 run	3	12	2.28	1800	G	
186	Autoignition Furnace		selected gas	1 run	3	20	60	48000	G	T
187	Autoignition Furnace		cleaning solvents	1 run	3	20	1	1	L	T
188	Autoignition Furnace		water	1 run	3	20	10	10	L	T
189	Autoignition Furnace		combustion products	1 run	3	20	TBD	TBD	S	F,T
190	Autoignition Furnace		gas chromatogr car.	1 run	3	20	0.004	2	G	
191	Autoignition Furnace		wipes	wipe	3	TBD	TBD	TBD		
192	Autoignition Furnace		oxygen	1 run	3	20	17	12000	G	
193	Glovebox		nitrogen	1 run	3	20	3.8	3000	G	
194	Cont Flow Electrophoresis		water	1 run	3	13	1820	1820	L	
195	Cont Flow Electrophoresis		buffer concentrate	1 run	3	13	36.4	36.4	L	C
196	Cont Flow Electrophoresis		culture medium	1 run	3	13	2.275	2.275	L	
197	Cont Flow Electrophoresis		disinfectants	1 run	3	13	2.6	2.6	L	T

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
198	Cont Flow Electrophoresis		raw material	1 run	3	13	0.91	0.91	L	
199	Cont Flow Electrophoresis		staining solution	1 run	3	13	0.13	0.13	L	
200	Cont Flow Electrophoresis		gloves	pair	3	13	0.26	1.3	S	
201	Cont Flow Electrophoresis		test tube	tube	3	52	0	0	S	
202	Cont Flow Electrophoresis		syringe	syringe	3	65	0.65	4.0625	S	
203	Cont Flow Electrophoresis		wipes	wipe	3	130	0.065	4.225	S	
204	Cont Flow Electrophoresis		nitrogen	1 run	3	26	4.94	3900	G	
205	Critical Point Phenomena		gaseous helium	1 run	3	6	0.216	1200	G	
206	Critical Point Phenomena		gaseous nitrogen	1 run	3	6	1.5	1200	G	
207	Critical Point Phenomena		helium (cooling)	1 run	3	6	21.96	123000	G	
208	Critical Point Phenomena		nitrogen (cooling)	1 run	3	6	145.8	117000	G	
209	Critical Point Phenomena		cleaning solution	1 run	3	6	0.06	0.06	L	T
210	Critical Point Phenomena		sample material	1 run	3	6	10.56	3	L	T
211	Critical Point Phenomena		wipes	wipe	3	30	0.015	0.975	S	T
212	Critical Point Phenomena		gloves	pair	3	12	0.24	1.2	S	T
213	Critical Point Phenomena		teflon O rings	ring	3	12	TBD	TBD	S	
214	Electroepitaxy		hydrogen	1 run	3	7	0.315	3500	G	F
215	Electroepitaxy		nitrogen	1 run	3	7	4.41	3500	G	
216	Electroepitaxy		arsenic	1 run	3	7	0.7	0.7	G	T
217	Electroepitaxy		boule fragments	1 run	3	7	0.168	0.14	S	T
218	Electroepitaxy		lab clothing etc.	1 run	3	7	7	294	S	T
219	Electroepitaxy		etchants	1 run	3	7	0.0035	0.0035	L	T
220	Electroepitaxy		gallium arsenide	1 run	3	7	0.875	0.875	S	T
221	Electroepitaxy		gallium	1 run	3	7	0.35	0.7	G	T
222	Electroepitaxy		polishing solution	1 run	3	7	7	7	L	C,F,T
223	Glovebox		nitrogen	1 run	3	28	5.32	4200	G	
224	Fluid Physics		cleaning solution	1 run	3	6	0.6	0.6	L	T
225	Fluid Physics		water	1 run	3	6	138	138	L	T
226	Fluid Physics		nitrogen	1 run	3	6	2.7	2160	G	
227	Fluid Physics		solvents	1 run	3	6	1.5	1.5	L	F,T
228	Fluid Physics		TGS solution	1 run	3	6	3	3	L	
229	Fluid Physics		cutting/polishing flui	1 run	3	6	6	6	L	T

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
230	Fluid Physics		xray film developer	1 run	3	6	TBD	TBD	L	T
231	Fluid Physics		xray film fixer	1 run	3	6	TBD	TBD	L	T
232	Glovebox		nitrogen	1 run	3	18	3.42	2700	G	
233	Gas Containers		gas containers	TBD	3	TBD	413	2190	S	
234	Glovebox		filters	TBD	3	TBD	TBD	TBD	S	
235	Glovebox		gloves from box	TBD	3	TBD	TBD	TBD	S	
236	Glovebox		cleaning solutions	TBD	3	TBD	TBD	TBD	L	
237	Glovebox		seals for box	TBD	3	TBD	TBD	TBD	S	
238	Glovebox		water	TBD	3	TBD	TBD	TBD	L	
239	Glovebox		wipes	TBD	3	TBD	TBD	TBD	S	
240	Glovebox		disinfectants	TBD	3	TBD	TBD	TBD	L	
241	Latex Reactor		cleaning fluids	1 run	3	6	0.06	0.06	L	F,T
242	Latex Reactor		initiator (AMBN)	1 run	3	6	0.006	0.006	S	F,T
243	Latex Reactor		latex solutions	1 run	3	6	0.006	0.006	L	
244	Latex Reactor		product spheres	1 run	3	6	0.0006	0.0006	S	F
245	Latex Reactor		styrene	1 run	3	6	0.006	0.006	L	F,T
246	Latex Reactor		wipes	wipe	3	6	0.003	0.195	S	
247	Latex Reactor		gloves	pair	3	6	0.12	0.6	S	
248	Latex Reactor		syringes	syringe	3	24	0.24	1.5	S	
249	Glovebox		nitrogen	1 run	3	12	2.28	1800	G	
250	Membrane Production		cleaning fluids	1 run	3	5	1.25	1.25	L	T
251	Membrane Production		water	1 run	3	5	2.5	2.5	L	T
252	Membrane Production		nitrogen	1 run	3	5	1.75	1400	G	
253	Membrane Production		catalyst solutions	1 run	3	5	0.005	0.005	G	F
254	Membrane Production		monomer solutions	1 run	3	5	0.005	0.005	L	F,T
255	Membrane Production		wipes	wipe	3	25	0.0125	0.8125	S	T
256	Membrane Production		gloves	glove	3	10	0.2	1	S	T
257	Membrane Production		syringes	syringe	3	50	0.5	3.125	S	
258	Glovebox		nitrogen	1 run	3	5	0.95	750	G	
259	Org and Poly Crys Growth		cleaning fluids	1 run	3	13	0.13	0.13	L	T
260	Org and Poly Crys Growth		water	1 run	3	13	52	52	L	T
261	Org and Poly Crys Growth		selected gas	1 run	3	13	7.67	3900	G	

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
262	Org and Poly Crys Growth		oxygen	1 run	3	13	5.2	3640	G	
263	Org and Poly Crys Growth		solvents	1 run	3	13	26	26	L	F,T
264	Org and Poly Crys Growth		melt vapors	1 run	3	13	0.0013	0.013	G	F,T
265	Org and Poly Crys Growth		wipes	wipe	3	39	0.0195	1.2675	S	T
266	Org and Poly Crys Growth		gloves	pair	3	26	0.52	2.6	S	T
267	Org and Poly Crys Growth		nitrogen	1 run	3	13	2.47	1950	G	
268	Protein Crystal Growth		water	1 run	3	7	4.9	4.9	L	T
269	Protein Crystal Growth		nitrogen	1 run	3	7	3.15	2520	G	
270	Protein Crystal Growth		argon	1 run	3	7	4.48	2508	G	
271	Protein Crystal Growth		oxygen	1 run	3	7	0.364	252	G	
272	Protein Crystal Growth		disinfectants	1 run	3	7	0.35	0.35	L	C,T
273	Protein Crystal Growth		raw protein solution	1 run	3	7	35	35	L	
274	Protein Crystal Growth		high vacuum wax	1 run	3	7	0.0245	0.21	S	F
275	Protein Crystal Growth		wipes	1 run	3	70	0.035	2.275	S	F,T
276	Protein Crystal Growth		syringes	1 run	3	700	7	43.75	S	T
277	Glovebox		nitrogen	1 run	3	21	3.99	3150	G	
278	Rotating Spherical Conv.		water	1 run	3	4	0.4	0.4	L	T
279	Rotating Spherical Conv.		cleaning fluid soln	1 run	3	4	2	2	L	
280	Rotating Spherical Conv.		gloves	pair	3	4	0.08	0.4	S	
281	Rotating Spherical Conv.		wipes	wipe	3	40	0.02	1.3	S	
282	Small Bridgman		argon	1 run	3	5	1.6	875	G	
283	Small Bridgman		water	1 run	3	5	10.5	10.5	L	T
284	Small Bridgman		boule fragments	1 run	3	5	0.85	0.15	S	F,T
285	Small Bridgman		ampoule fragments	1 run	3	5	1.15	0.45	S	
286	Small Bridgman		etchants	1 run	3	5	0.025	0.025	L	T
287	Small Bridgman		cut/polishing fluid	1 run	3	5	2.5	2.5	L	T
288	Small Bridgman		wipes	wipe	3	50	0.025	1.625	S	T
289	Small Bridgman		gloves	pair	3	10	0.2	1	S	T
290	Small Bridgman		saw blades	blade	3	20	TBD	TBD	S	T
291	Glovebox		nitrogen	1 run	3	20	3.8	3000	G	
292	Solution Crystal		water	1 run	3	13	230.1	230.1	L	T
293	Solution Crystal		nitrogen	1 run	3	13	5.85	4693	G	

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
294	Solution Crystal		sodium aluminate	1 run	3	13	11.96	11.96	L	T
295	Solution Crystal		sodium chlorate	1 run	3	13	5.07	5.07	L	T
296	Solution Crystal		sodium hydroxide	1 run	3	13	1.95	1.95	L	T
297	Solution Crystal		cleaning solutions	1 run	3	13	26	26	L	T
298	Solution Crystal		solvents	1 run	3	13	3.25	3.25	L	F,T
299	Solution Crystal		TGS solution	1 run	3	13	6.5	6.5	L	
300	Solution Crystal		cutting/polishing flui	1 run	3	13	13	13	L	
301	Solution Crystal		xray film developer	1 run	3	13	TBD	TBD	L	T
302	Solution Crystal		xray film fixer	1 run	3	13	TBD	TBD	L	T
303	Solution Crystal		sodium metasilicate	1 run	3	13	TBD	TBD	S	
304	Glovebox		nitrogen	1 run	3	39	7.41	5850	G	
305	Vapor Crystal		argon	1 run	3	10	2.9	1600	G	
306	Vapor Crystal		air	1 run	3	10	5.6	4480	G	
307	Vapor Crystal		cleaning fluid	1 run	3	10	40	40	L	
308	Vapor Crystal		ampoule fragments	1 run	3	10	7.2	2.8	S	
309	Vapor Crystal		etchants solution	1 run	3	10	0.4	0.4	L	C,T
310	Vapor Crystal		polishing solutions	1 run	3	10	40	40	L	F,T
311	Vapor Crystal		transport agent	1 run	3	10	2.9	200	G	T
312	Vapor Crystal		boule fragments	1 run	3	10	35	3.5	S	T
313	Vapor Crystal		wipes	wipe	3	100	0.05	3.25	S	
314	Vapor Crystal		gloves	pair	3	20	0.4	2	S	
315	Vapor Crystal		saw blades	blade	3	20	TBD	TBD	S	
316	Vapor Crystal		seals for modules	seal	3	40	TBD	TBD	S	
317	Glovebox		nitrogen	1 run	3	20	3.8	3000	G	

7.4 External Attached Payloads

7.4.1 SAAX 0001 — Cosmic Ray Nuclei Experiment (CRNE)

MISSION CONTACT(S): Vernon Jones (HQ)*, Jacques L'Heureux (Univ. of Chicago), Dr. Dietrich Muller (Univ. of Chicago)

MISSION DESCRIPTION: Electronic counter telescope consisting of two scintillation counters, two Cerenkov counters, a transition radiation detector system each followed by a multi-wire proportional counter, all inside a pressurized container attached to upper boom. Power, telemetry, pointing, and contamination control requirements satisfied by Station. View direction anti-earth; no part of station in 140^{o} field of view.

OPERATIONAL LIFETIME: Two-year exposure baselined for early IOC.

SERVICING/MAINTENANCE INTERVAL: No on-orbit servicing planned.

SERVICING SCENARIO
EVA: No service required.

IVA: None

COMMON HARDWARE: None; simple mounting fixture including power and data buses.

EXPERIMENT PAYLOADS: Self-contained (sealed) instrument package.

CONSUMABLES: 360 kg "gases" (plus 165 kg container) used during lifetime to maintain instrument environment; N_2-CO_2 mixture, or Xe-Methane-He mixture, previously used on Spacelab 2.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: None.

COMMENTS: Gas mixture to be used on Space Station will be one of two mentioned in Consumables. There is no recharging, so no containers will be removed. May require active cooling which in turn may require linkage to Space Station heat rejection system.

REFERENCES: MRDB, BDM Study

7.4 External Attached Payloads

7.4.2 SAAX 0010 — Advanced Solar Observatory/Solar Optical Telescope (ASO/SOT) Mission

MISSION CONTACT(S): Dr. Gabriel Epstein (GSFC)*

MISSION DESCRIPTION: To study the physics of the Sun on the scale at which many of its important physical processes occur. The SOT facility will be composed of an optical telescope, an instrument pointing subsystem, and a set of focal plane instruments.

OPERATIONAL LIFETIME: 10 years.

SERVICING/MAINTENANCE INTERVAL: 12 month maintenance and/or instrument upgrade. Film changeout approximately once/month (exact interval TBD).

SERVICING SCENARIOS:

EVA: Component replacement, instrument or facility module replacement, film canister changeout.

IVA: Monitor EVA activities, operate Mobile Remote Manipulator System, repair instruments.

COMMON HARDWARE: See following table.

EXPERIMENT PAYLOADS: 1.0 m optical telescope, focal plane instruments, instrument pointing subsystem.

CONSUMABLES: Film for photometric filtergraph.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: See following table.

COMMENTS: Film changeout procedure may transition to teleoperations or robotics. If a charge-coupled device is adopted, film changeout no longer necessary. SOT is current instrument; will become High Resolution Solar Observatory (HRSO) for Space Station

REFERENCES: MRDB, BDM Study, "Space Station Attached Payload Accommodation Requirements Definition for the Solar Optical Telescope", Advanced Missions Analysis Office, Goddard SFC, March 1985 (DRAFT)

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
7	SOT	IVA control	paper	5-10 of 8.5 x 11	3	45	1.69	2.66	S	
8	SOT	IVA control	paper	sht chrt/plot pape	3	450	2.25	3.47	S	

7.4 External Attached Payloads

7.4.3 SAAX 0010A — Advanced Solar Observatory/Solar Optical Telescope (ASO/SOT) Mission Servicing

MISSION CONTACT(S): Dr. Gabriel Epstein (GSFC)*

MISSION DESCRIPTION: Maintain instrument performance, replace film, and upgrade focal-plane instruments. Servicing is performed on the Space Station.

OPERATIONAL LIFETIME: N/A

SERVICING/MAINTENANCE INTERVAL: 12 month maintenance and/or instrument upgrade. Film changeout approximately once/month (exact interval TBD).

SERVICING SCENARIOS:

EVA: See 7.4.2, SAAX 0010.

IVA: See 7.4.2, SAAX 0010.

COMMON HARDWARE: See following table.

EXPERIMENT PAYLOADS: See 7.4.2, SAAX 0010.

CONSUMABLES: Film for photometric filtergraph.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: See following table.

COMMENTS: Film changeout procedure may transition to teleoperations or robotics. If a charge-coupled device is adopted, film changeout no longer necessary. SOT is current instrument; will become High Resolution Solar Observatory (HRSO) for Space Station

REFERENCES: MRDB, BDM Study, "Space Station Attached Payload Accommodation Requirements Definition for the Solar Optical Telescope", Advanced Missions Analysis Office, Goddard SFC, March 1985 (DRAFT)

ID#	Hardware	Procedure	Waste Item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
9	SOT	instr. purge	inert gas	purge	12	TBD	TBD	TBD	G	
10	SOT	instr. change	thermal blanket	scraps	12	TBD	TBD	TBD	S	
11	SOT	instr. change	tape	scraps	12	TBD	TBD	TBD	S	

7.4 External Attached Payloads

7.4.4 SAAX 0011 — Advanced Solar Observatory: Pinhole/Occulter Facility (ASO/POF) Mission

MISSION CONTACT(S): Bill Roberts (MSFC), Hugh Hudson (UCSD)*

MISSION DESCRIPTION: The POF will study the phenomena of plasma dynamics in the solar corona that are far from equilibrium and to observe the acceleration of non-thermal particles in solarflares and coronal disturbances. These are observed with X-ray and coronagraphic equipment.

OPERATIONAL LIFETIME: 15 years.

SERVICING/MAINTENANCE INTERVAL: 5 years.

SERVICING SCENARIOS:

EVA: Replace sealed proportional counters, replace other components or instruments as needed.

IVA: Monitor EVA activities, operate Mobile Remote Manipulator System, repair instruments.

COMMON HARDWARE: See following table.

EXPERIMENT PAYLOADS: X-ray detectors, solar coronal imaging optics, UV coronagraph/spectrometer, visible/UV coronagraph, occulter plane (pinhole mask, occulting edge and disk mounted on end of 32 meter boom).

CONSUMABLES: None identified.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: See following table.

COMMENTS: Instrument changeout or upgrade is not firmly planned at this time.

REFERENCES: MRDB, BDM Study

SAAX 0011 – ADVANCED SOLAR OBSERVATORY / PINHOLE OCC. FACILITY

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
12	Electronics		failed components	component	60	TBD	TBD	TBD	S	
13	Control/Display		paper	10 sheets	3	90	4.5	6.93	S	

7.4 External Attached Payloads

7.4.5 SAAX 0011A — Advanced Solar Observatory: Pinhole/Occulter Facility (ASO/POF) Mission Servicing

MISSION CONTACT(S): Bill Roberts (MSFC), Hugh Hudson (UCSD)*

MISSION DESCRIPTION: Maintain instrument performance, upgrade existing instruments, and install new instruments in the instrument plant of the facility. Servicing done on the Space Station.

OPERATIONAL LIFETIME: N/A

SERVICING/MAINTENANCE INTERVAL: 5 years.

SERVICING SCENARIOS:

EVA: Replace sealed proportional counters, replace other components or instruments as needed.

IVA: Monitor EVA activities, operate Mobile Remote Manipulator System, repair instruments.

COMMON HARDWARE: See 7.4.4, SAAX 0011.

EXPERIMENT PAYLOADS: See 7.4.4, SAAX 0011.

CONSUMABLES: None identified.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: None identified.

COMMENTS: Instrument changeout or upgrade is not firmly planned at this time.

REFERENCES: MRDB, BDM Study

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7.4 External Attached Payloads

7.4.6 SAAX 0021 — Superconducting Magnet Facility (SMF)

MISSION CONTACT(S): Jonathan Ormes (GSFC), Vernon Jones (HQ)*

MISSION DESCRIPTION: This facility will study cosmic ray phenomena, search for antimatter (antinuclei, antiprotons) and probe galactic magnetic fields. Attached P/L (top boom); power, telemetry requirements supplied by the Station.

OPERATIONAL LIFETIME: Indeterminate; at least 7 years (MRDB).

SERVICING/MAINTENANCE INTERVAL: One year.

SERVICING SCENARIO

EVA: Change out particle detectors; recharge liquid helium dewar.

IVA: Monitor EVA, operate Mobile Remote Manipulator System.

COMMON HARDWARE: Mounting fixture, power supply, telemetry equipment.

EXPERIMENT PAYLOADS: Science instruments (TBD).

CONSUMABLES: Liquid helium (250 kg) in 2200 kg container.

LIMITED LIFE PARTS: Charged particle track detectors.

WASTE ITEMS: See attached table

COMMENTS: Detector change out when experiment objectives change.

REFERENCES: MRDB, BDM Study, "ASTROMAG, The Particle Astrophysics Magnet Facility", MS from NASA Code EZ, 1986

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ID#	Hardware	Procedure	Waste Item	Unit	SI	#/SI	kg/S	ltr/SI	Phase	Code
27	Cooling System	SMF	helium	spillage	12	TBD	250	1540000	G	

7.4 External Attached Payloads

7.4.7 SAAX 0030 — Space Station Hitchhiker 1 (HH1)

MISSION CONTACT(S): Ted Goldsmith (GSFC)*

MISSION DESCRIPTION: The existing Hitchhiker-G Program is designed to efficiently fly small payloads on the Shuttle mounted either in opening door canisters or on mounting plates and with simple standard electrical interfaces. The Space Station Hitchhiker would maintain these same customer mechanical and electrical interfaces to allow shuttle instruments to move up to Space Station with little or no modification. The Space Station version will have a cross-bay structure and will accommodate up to 12 customer instruments in canisters or on plates. The entire carrier would be changed out periodically and there may be requirements for EVA changeout of feedstock/product, film or instruments for individual customer payloads.

OPERATIONAL LIFETIME: 3 months to 3 years for experiments; platform lifetime indefinite.

SERVICING/MAINTENANCE INTERVAL: Indefinite (for platform itself).

SERVICING SCENARIOS:
EVA: Change out HH payloads (modular).

IVA: Monitor EVA (possibly assist using Mobile Remote Manipulator System).

COMMON HARDWARE: None identified.

EXPERIMENT PAYLOADS: Experiment dependent.

CONSUMABLES: None (on platform).

WASTE ITEMS: None identified.

COMMENTS: Possible use of robotics or teleoperation to change out payloads. Payloads defined by individual investigators; some payload modules may require SS storage for a period of time dependent on STS flight schedules. No plans at this time to adapt MSFC cross-bay (bridge) HH configuration to SS use.

REFERENCES: MRDB, BDM Study

7.4 External Attached Payloads

7.4.8 SAAX 0031 — Space Station Hitchhiker 2 (HH2)

MISSION CONTACT(S): Ted Goldsmith (GSFC)*

MISSION DESCRIPTION: The existing Hitchhiker-G Program is designed to efficiently fly small payloads on the Shuttle mounted either in opening door canisters or on mounting plates and with simple standard electrical interfaces. The Space Station Hitchhiker would maintain these same customer mechanical and electrical interfaces to allow shuttle instruments to move up to Space Station with little or no modification. The Space Station version will have a cross-bay structure and will accommodate up to 12 customer instruments in canisters or on plates. The entire carrier would be changed out periodically and there may be requirements for EVA changeout of feedstock/product, film or instruments for individual customer payloads.

OPERATIONAL LIFETIME: 3 months to 3 years (TBD).

SERVICING/MAINTENANCE INTERVAL: 6 months.

SERVICING SCENARIOS:

EVA: Change out HH payloads (modular).

IVA: Monitor EVA (possibly assist using Mobile Remote Manipulator System).

COMMON HARDWARE: None identified.

EXPERIMENT PAYLOADS: Experiment dependent.

CONSUMABLES: None (on platform).

WASTE ITEMS: None identified.

COMMENTS: Possible use of robotics or teleoperation to change out payloads. Payloads defined by individual investigators; some payload modules may require SS storage for a period of time dependent on STS flight schedules. No plans at this time to adapt MSFC cross-bay (bridge) HH configuration to SS use.

REFERENCES: MRDB, BDM Study

7.4 External Attached Payloads

7.4.9 SAAX 0032 — Space Station Hitchhiker 3 (HH3)

MISSION CONTACT(S): Ted Goldsmith (GSFC)*

MISSION DESCRIPTION: The existing Hitchhiker-G Program is designed to efficiently fly small payloads on the Shuttle mounted either in opening door canisters or on mounting plates and with simple standard electrical interfaces. The Space Station Hitchhiker would maintain these same customer mechanical and electrical interfaces to allow shuttle instruments to move up to Space Station with little or no modification. The Space Station version will have a cross-bay structure and will accommodate up to 12 customer instruments in canisters or on plates. The entire carrier would be changed out periodically and there may be requirements for EVA changeout of feedstock/product, film or instruments for individual customer payloads.

OPERATIONAL LIFETIME: 3 months to 3 years (TBD).

SERVICING/MAINTENANCE INTERVAL: 6 months.

SERVICING SCENARIOS:

EVA: Change out HH payloads (modular).

IVA: Monitor EVA (possibly assist using Mobile Remote Manipulator System).

COMMON HARDWARE: None identified.

EXPERIMENT PAYLOADS: Experiment dependent.

CONSUMABLES: None (on platform).

WASTE ITEMS: None identified.

COMMENTS: Possible use of robotics or teleoperation to change out payloads. Payloads defined by individual investigators; some payload modules may require SS storage for a period of time dependent on STS flight schedules. No plans at this time to adapt MSFC cross-bay (bridge) HH configuration to SS use.

REFERENCES: MRDB, BDM Study

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7.4 External Attached Payloads

7.4.10 SAAX 0112 — Cosmic Dust Collection Experiment (CDCE)

MISSION CONTACT(S): Fredrich Horz (JSC)*

MISSION DESCRIPTION: The objective is to determine the nature, abundance, distribution and character of cosmic dust particles by collecting such particles and measuring their orbital trajectories. There is a variety of experiments and collecting panels which are deployed and retrieved from the Space Station.

OPERATIONAL LIFETIME: 10-15 years.

SERVICING/MAINTENANCE INTERVAL: 3 months.

SERVICING SCENARIOS:

EVA: Dust collector cell changeout.

IVA: Monitor EVA.

COMMON HARDWARE: See following table.

EXPERIMENT PAYLOADS: Cuboidal framework containing cell units, attached to end of boom.

CONSUMABLES: Small (5 x 5 cm) aperture cells to collect dust particles.

LIMITED LIFE PARTS: Small (5 x 5 cm) aperture cells to collect dust particles.

WASTE ITEMS: See following table.

COMMENTS: "Fresh" cells stored in logistics module; strictly speaking, the cells are not "consumables" since they are primary means of data collection and must be returned to earth for study.

REFERENCES: MRDB, BDM Study, "Trajectory Determinations and Collection of Micrometeoroids on the Space Station", LPI Technical Report number 86-05, Lunar and Planetary Institute, Houston, 1986

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SAAX 0112 – COSMIC DUST COLLECTION EXPERIMENT

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
47	Electronics		failed component	component	6	TBD	TBD	TBD	S	

7.4 External Attached Payloads

7.4.11 SAAX 0115 — Astrometric Telescope - Extrasolar (AT)

MISSION CONTACT(S): Jurgen Rahe (HQ), Kenji Nishioka (ARC)*

MISSION DESCRIPTION: This mission will determine the existence of Uranus/Neptune size planets orbiting nearby stars by detecting small variations in stellar motions. The mission consists of an astrometric telescope attached to the manned station which will produce stellar positional information over a period of many years.

OPERATIONAL LIFETIME: 10-20 years.

SERVICING/MAINTENANCE INTERVAL: 5 years.

SERVICING SCENARIOS:

EVA: Replacement of components or facility modules.

IVA: Monitor EVA (possibly operate Mobile Remote Manipulator System); possible contingency repair of failed components inside pressurized module.

COMMON HARDWARE: Embedded Data Processor (EDP), Standard Data Processor (SDP), Multiplexer/Demultiplexer (MDM), Network Interface Unit (NIU) (Note: all of the preceding are SS DMS common Electronics); Power Converter Boards — SS Power S/S Common Hardware.

EXPERIMENT PAYLOADS: 1.1-1.5 m diameter reflecting telescope, focal plane instrumentation.

CONSUMABLES: None.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: None identified.

COMMENTS:

REFERENCES: MRDB, BDM Study

7.4 <u>External Attached Payloads</u>

7.4.12 SAAX 0207 — Solar Terrestrial Observatory (STO)

MISSION CONTACT(S): Bill Roberts (MSFC)*

MISSION DESCRIPTION: The STO is a collection of 11 separate experiments (instruments) mounted on the SS structure (upper and lower booms), on 3 Spacelab-type pallets, on a boom or MRMS, or on a polar platform or other free-flyer bus.

OPERATIONAL LIFETIME: Overall observatory, 10 years — specific instruments have other lifetimes.

SERVICING/MAINTENANCE INTERVAL: Instruments require servicing every 1-36 months.

SERVICING SCENARIOS:
EVA: Refer to individual experiments (SAAX 0207A-J).

IVA: Refer to individual experiments (SAAX 0207A-J).

COMMON HARDWARE: Pallets with standard interface connectors and cold plates for heat dissipation from active experiments.

EXPERIMENT PAYLOADS: Eleven interrelated instrument packages — refer to individual experiments (SAAX 0207A-J).

CONSUMABLES: Refer to individual experiments (SAAX 0207A-J).

LIMITED LIFE PARTS: Refer to individual experiments (SAAX 0207A-J).

WASTE ITEMS: See following tables for individual experiments.

COMMENTS: This "mission" includes several experiments, each of which is treated as a separate mission in the MRDB. This report covers seven of the 11 planned experiments.

REFERENCES: MRDB, BDM Study, Payload Database (TRW), GSFC Miniworkshop Report, SAIC Operational Scenario for STO.

7.4 External Attached Payloads

7.4.13 SAAX 0207A — Active Cavity Radiometer Irradiance Monitor (ACRIM)

MISSION CONTACT(S): R. C. Willson (JPL)*

MISSION DESCRIPTION: ACRIM comprises three active cavity radiometer detectors (pyroheliometers), electrically self-calibrated, which measure total solar irradiance from far UV through far IR with maximum accuracy and precision.

OPERATIONAL LIFETIME: 5 years.

SERVICING/MAINTENANCE INTERVAL: 1 year.

SERVICING SCENARIOS:

EVA: Contingency component changeout, configuration change.

IVA: Radiometer calibration (JPL reference instrument).

COMMON HARDWARE: Protective door.

EXPERIMENT PAYLOADS: Radiometers.

CONSUMABLES: None identified.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: None identified.

COMMENTS:

REFERENCES: MRDB, BDM Study, Payload Database (TRW), GSFC Miniworkshop Report, SAIC Operational Scenario for STO.

7.4 External Attached Payloads

7.4.14 SAAX 0207C — Solar UV High Resolution Telescope and Spectrograph (HRTS)

MISSION CONTACT(S): Dr. Guenter Brueckner (NRL)*

MISSION DESCRIPTION: HRTS contains instruments to measure energy output of the sun and of solar flares, prominence, spicules, etc. in the 117.6-179 nm UV range with high spatial resolution, high spectral resolution, and large linear coverage.

OPERATIONAL LIFETIME: 7 years.

SERVICING/MAINTENANCE INTERVAL: 1 month.

SERVICING SCENARIOS:

EVA: Film changeout, possible optical element changeout (if contaminated), contingency component changeout, inspection.

IVA: Component repair, EVA monitoring.

COMMON HARDWARE: Protective door on canister, thermal protection canister.

EXPERIMENT PAYLOADS: Telescope, UV spectrograph, broad-band heliograph, H alpha slit display system.

CONSUMABLES: Film (cartridge).

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: See following table.

COMMENTS: Film must be protected from radiation to avoid fogging.

REFERENCES: MRDB, BDM Study, Payload Database (TRW), GSFC Miniworkshop Report, SAIC Operational Scenario for STO.

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
51	Control Workstation		paper	5 sheets	3	30-480	18	27.2	S	

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7.4 External Attached Payloads

7.4.15 SAAX 0207E — Solar UV Spectral Irradiance Monitor (SUSIM)

MISSION CONTACT(S): Dr. Guenter Brueckner (NRL)*

MISSION DESCRIPTION: SUSIM contains instruments designed to measure irradiance in specific solar UV spectral regions (120-400 nm, both continuum and line, comparative measurements above and below 208 nm) with great accuracy.

OPERATIONAL LIFETIME: 5 years.

SERVICING/MAINTENANCE INTERVAL: 6 months major EVA, daily IVA maintenance.

SERVICING SCENARIOS:

EVA: Calibration, contingency component changeout (failed components).

IVA: Calibration/stability tracking, component repair.

COMMON HARDWARE: Steel canister (sealed), protective door.

EXPERIMENT PAYLOADS: Scanning spectrometer (2), 5 photo diodes, 2 photon counters, calibration light source (deuterium lamp).

CONSUMABLES: Argon.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: Argon container.

COMMENTS: Calibration/stability tracking (IVA) performed daily.

REFERENCES: BDM, STO Payload Database, SAIC Operational Scenario

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7.4 External Attached Payloads

7.4.16 SAAX 0207F — Space Experiments with Particle Accelerators (SEPAC)

MISSION CONTACT(S): J. L. Burch (SWRI)*

MISSION DESCRIPTION: SEPAC is an active experiment; the instrument injects particle beams into the plasma/atmospheric environment of Space Station and resulting phenomena are observed by TV camera, and by plasma and field diagnostic instrumentation.

OPERATIONAL LIFETIME: 5 years.

SERVICING/MAINTENANCE INTERVAL: Battery inspection, 3 months; gas/filament resupply, 6 months; battery resupply, 6 months.

SERVICING SCENARIOS:

EVA: Replace batteries, remove accelerator head (to be brought inside), replenish N_2, remove and replace other (failed) components as needed.

IVA: Replace cathode in accelerator head, monitor EVA, possibly repair electronics.

COMMON HARDWARE: Pallet interfaces with SS power supply. Internal rack-mounted power control.

EXPERIMENT PAYLOADS: Electron accelerator, plasma accelerator, N_2 release device, particle and field diagnostic instruments, low-light TV.

CONSUMABLES: Nitrogen, argon, and xenon gas.

LIMITED LIFE PARTS: Electron beam cathode, batteries.

WASTE ITEMS: See following table.

COMMENTS: SEPAC coordinated with 6 other STO experiments by payload specialist.

REFERENCES: MRDB, BDM Study, Payload Database (TRW), GSFC Miniworkshop Report, SAIC Operational Scenario for STO.

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
53	Plasma source		argon	recharging	36	1	TBD	TBD	G	
54	Plasma source		xenon	recharging	36	1	TBD	TBD	G	
55	Electron guns		cathode element	element	36	1	11	1.178	S	
56	Electron guns		batteries	battery	36	1	75	380	S	

7.4 External Attached Payloads

7.4.17 SAAX 0207G — Waves in Space Plasma (WISP)

MISSION CONTACT(S): William W. L. Taylor (TRW)*

MISSION DESCRIPTION: WISP is a package of radio transmitters and receivers which will enable study of the magnetosphere, ionosphere and atmosphere. It is a pallet-mounted active experiment broadcasting in 1kHz-30mHz range, and has a dipole antenna extendable to 300 m tip-to-tip.

OPERATIONAL LIFETIME: 5 years.

SERVICING/MAINTENANCE INTERVAL: TBD.

SERVICING SCENARIOS:
EVA: TBD.

IVA: TBD.

COMMON HARDWARE: Pallet, diagnostic and support equipment.

EXPERIMENT PAYLOADS: Plasma wave transmitters, receivers, antennas.

CONSUMABLES: None.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: None identified.

COMMENTS: No servicing currently planned, but there may be some component changeouts.

REFERENCES: MRDB, BDM Study, Payload Database (TRW), GSFC Miniworkshop Report, SAIC Operational Scenario for STO.

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7.4 External Attached Payloads

7.4.18 SAAX 0207H — Theoretical and Experimental Beam Plasma Physics (TEBPP)

MISSION CONTACT(S): H. R. Anderson (SAIC)*

MISSION DESCRIPTION: Diagnostic system used in connection with SEPAC or other accelerators to measure various aspects of the interaction of an electron beam with ionospheric plasma and the neutral atmosphere. Package of 5 instruments mounted on a boom on MRMS.

OPERATIONAL LIFETIME: 5 years.

SERVICING/MAINTENANCE INTERVAL: No fixed interval; no planned servicing.

SERVICING SCENARIOS:

EVA: None planned.

IVA: None planned.

COMMON HARDWARE: MRMS grapple fixture with power bus.

EXPERIMENT PAYLOADS: Plasma probe, plasma wave receiver, particle spectrometer, neutral density detector, photometer.

CONSUMABLES: None.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: See following table.

COMMENTS: There have been discussions of conducting the TEBPP mission as a free-flyer. TEBPP operates in conjunction with SEPAC and AEPI.

REFERENCES: MRDB, BDM Study, Payload Database (TRW), GSFC Miniworkshop Report, SAIC Operational Scenario for STO.

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ID#	Hardware	Procedure	Waste Item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
58	Detectors	Remove & replace	failed sensor head unit	unit	0	1	5	27	S	

7.4 External Attached Payloads

7.4.19 SAAX 0250 — Hitchhiker 4 (HH4) (also called Earth Radiation Budget Experiment — ERBE)

MISSION CONTACT(S): Robert Schiffer (HQ)*

MISSION DESCRIPTION: To sample the radiative output of the tropics as a function of time of day. Mounted on Earth viewing surface of manned Space Station, it is to be operated continuously and repaired if necessary.

OPERATIONAL LIFETIME: 3 months to 3 years (TBD).

SERVICING/MAINTENANCE INTERVAL: 6 months (TBD).

SERVICING SCENARIOS:

EVA: None (see comments).

IVA: None (see comments).

COMMON HARDWARE: None identified.

EXPERIMENT PAYLOADS: Instruments are similar to those carried aboard the current ERBS satellite, consisting of scanning and non-scanning modules. Each module measures reflected short wave (<5 um) solar radiation and Earth emitted longwave (>5 um) thermal radiation. The direct solar irradiance is also measured.

CONSUMABLES: None.

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: None identified.

COMMENTS: As a Hitchhiker experiment, there are no plans for on-orbit servicing; however, either SS or STS crew will have to mount payload on HH platform.

REFERENCES: MRDB, BDM Study

7.4 External Attached Payloads

7.4.20 SAAX 0251 — Tropical Rainfall Mapping Mission (TRMM)

MISSION CONTACT(S): Gerald North (Texas A & M), Tom Keating (GSFC)*

MISSION DESCRIPTION: This experiment willl measure tropical rainfall (minimum of 3 years data) in order to increase understanding of energetic and hydrologic processes.

OPERATIONAL LIFETIME: 10 years.

SERVICING/MAINTENANCE INTERVAL: 1-3 years. Specific component schedules: 1 year — calibration; 3 years — instrument changeout and replacement or refurbishment; as required (up to 6 years) — scan motor replacement, processor repair, mirror cleaning.

SERVICING SCENARIOS:

EVA: Contingency removal/replacement of components and instruments, calibration of sensors.

IVA: Clean AVHRR mirrors, repair motor, processor, refurbish ESMR or AVHRR.

COMMON HARDWARE: None identified.

EXPERIMENT PAYLOADS: Experiment package consists of three individual instruments — an Advanced Very High Resolution Radiometer (AVHRR), an Electrically Scanned Microwave Radiometer (ESMR) and a 2-frequency scanning meteorological radar. These three instruments work together although they can be mounted individually.

CONSUMABLES: None if attached payload; propellant if free-flyer

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: TBD.

COMMENTS: Preferred mode would be as free-flyer, with a minimum orbital altitude of 300 km.

REFERENCES: MRDB, BDM Study, Memorandum: "TRMM Phase-A Implementation Plan...", Code 402, Goddard Spaceflight Center, June 1986.

7.4 External Attached Payloads

7.4.21 SAAX 0502 — Space-Based Antenna Test Range (SBAR)

MISSION CONTACT(S): Thomas Campbell (LaRC)*

MISSION DESCRIPTION: The mission objective is to test communication links and determine antenna characteristics of new or experimental antennas on free-flyers or communications satellites prior to their deployment. A two-person crew will work in the pressurized area, in conjunction with a dedicated remotely-controlled and instrumented free-flyer. The spacecraft or antenna to be tested would be attached to the station while the SBAR free-flyer with RF test equipment would co-orbit 20-200 nmi from SS and intercept and relay their antenna patterns back to the Space Station for analysis. A window adjacent to the crew workstation is required for visual observations.

OPERATIONAL LIFETIME: 15 years.

SERVICING/MAINTENANCE INTERVAL: 1 month

SERVICING SCENARIOS:

EVA: Change out equipment approximately every 20 days (this activity considered operational in BDM study); assemble/deploy free flyer; refuel free flyer; remove/replace spacecraft components.

IVA: Monitor EVA; repair spacecraft components or test equipment.

COMMON HARDWARE: MMS-type spacecraft with propulsion, attitude control, power, and communications/data handling subsystems. Spacecraft also fitted with test antenna, high-gain antenna, and (possibly) solar arrays. Test area on SS (external) has mounting interfaces (some steerable) for antennas to be tested, possibly also a thermal shroud/shield.

EXPERIMENT PAYLOADS: Test electronics and antenna for specific tests.

CONSUMABLES: Free-flier propellant (type TBD).

LIMITED LIFE PARTS: None identified.

WASTE ITEMS: None identified at present; see Comments.

COMMENTS: This mission is currently unfunded and planning is at the basic science stage, so all information is tentative. Dick Kurz at JSC is tracking equipment to be used inside pressurized module.

REFERENCES: MRDB, BDM Study

7.5 Free-flyers and Co-orbiting Platforms

7.5.1 SAAX 0004 — Space Infrared Telescope Facility (SIRTF) Mission

MISSION CONTACT(S): Larry Manning (ARC), Chris Wiltsee (ARC)*

MISSION DESCRIPTION: To determine the composition, structure, and evolution of infrared sources and the nature of the physical processes occurring in them. The telescope is cryogenically cooled by liquid helium to temperatures below 10 K to assure that the radiation from the telescope itself is below the natural thermal noise background.

OPERATIONAL LIFETIME: 5 years (10 year goal).

SERVICING/MAINTENANCE INTERVAL: 18-24 months.

SERVICING SCENARIOS:

EVA: Place protective covers on contamination-sensitive components and remove before redeployment; attach/detach cryogen transfer lines; maintain support systems, change out failed components.

IVA: Deploy OMV to retrieve SIRTF; monitor EVA operations; monitor cryogen transfer; deploy SIRTF to orbit using OMV; repair components (contingency) inside pressurized module.

COMMON HARDWARE: Present baseline SIRTF makes use of Multimission Modular Spacecraft (MMS) subsystems, including ACS, C&DH, and MPS modules, plus HST reaction wheels and SA/HGA from Landsat 4.

EXPERIMENT PAYLOADS: Infrared Array Camera, Infrared Spectrometer, Multiband Imaging Photometer.

CONSUMABLES: Cryogen-superfluid helium, duct tape.

LIMITED LIFE PARTS: Batteries, tape recorders, solar arrays, other components not identified.

WASTE ITEMS: Gaseous helium vented at ~ 6.4 mg/sec, 250 K, from SIRTF throughout mission, helium container.

COMMENTS: Co-orbiting platform mounting option under consideration, but initial version will fly on Multimission Modular Spacecraft (MMS) bus. Helium loss during servicing would increase dramatically if SIRTF is allowed to warm up. Helium container also used by other astrophysics missions, e.g. SMF and AXAF.

REFERENCES: BDM Study, MRDB, Customer Servicing Requirements Databook

7.5 <u>Free-flyers and Co-orbiting Platforms</u>

7.5.2 SAAX 0004A — Space Infrared Telescope Facility (SIRTF) Servicing

MISSION CONTACT(S): Larry Manning (ARC), Chris Wiltsee (ARC)*

MISSION DESCRIPTION: Service externally accessible equipment and resupply superfluid helium. SIRTF will be retrieved by the OMV and serviced at the Space Station.

OPERATIONAL LIFETIME: N/A

SERVICING/MAINTENANCE INTERVAL: 18-24 months.

SERVICING SCENARIOS:

EVA: Place protective covers on contamination-sensitive components and remove before redeployment; attach/detach cryogen transfer lines; maintain support systems, change out failed components.

IVA: Deploy OMV to retrieve SIRTF; monitor EVA operations; monitor cryogen transfer; redeploy SIRTF using OMV; (contingency) repair components inside pressurized module.

COMMON HARDWARE: See following table.

EXPERIMENT PAYLOADS: Infrared Array Camera, Infrared Spectrometer, Multiband Imaging Photometer.

CONSUMABLES: Superfluid helium, tape.

LIMITED LIFE PARTS: Batteries, tape recorders, solar arrays, other components not identified.

WASTE ITEMS: See following table.

COMMENTS: Co-orbiting platform mounting option under consideration, but initial version will fly on Multimission Modular Spacecraft (MMS) bus. Helium loss during servicing would increase dramatically if SIRTF is allowed to warm up.

REFERENCES: BDM Study, MRDB, Customer Servicing Requirements Databook

ID#	Hardware	Procedure	Waste Item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
3	SIRTF Observatory	storage venting	gaseous He	storage vent	24	1	7.741	43300	G	
4	Transfer Dewar	storage venting	gaseous He	storage vent	24	1	46	257000	G	
5	Transfer Dewar	recharge venting	gaseous He	recharge vent	24	1	145	812000	G	
6	SIRTF Observatory	recharge venting	gaseous He	recharge vent	24	1	34	190000	G	

7.5 Free-flyers and Co-orbiting Platforms

7.5.3 SAAX 0012 — Hubble Space Telescope (HST) Servicing

MISSION CONTACT(S): Jim Welch (HQ)*

MISSION DESCRIPTION: Free-flying celestial pointer, 700 km, 28.5^o orbit. No on-board boost capability (serviced/reboosted by OMV). Contains Optical Telescope Assembly (OTA), Science Instruments (SI's, 6), and Systems Support Module (SSM, 10 bays).

OPERATIONAL LIFETIME: 15 years

SERVICING/MAINTENANCE INTERVAL: 3 years (first servicing from STS)

SERVICING SCENARIO

EVA: HST will be retrieved from orbit and brought to SS by OMV. ORU's (OSU's) including SI's will be changed out for replacements carried on Spacelab pallet, stored externally at SS in thermally controlled environment. Some SI's purged with dry N_2.

IVA: Contingency repairs of some OSU's contemplated, as is on orbit servicing of some SI's

COMMON HARDWARE: Systems Support Module (SSM), support structure with protective doors.

EXPERIMENT PAYLOADS: Optical telescope assembly and science instruments.

CONSUMABLES: Dry N_2, lubricants, tape.

LIMITED LIFE PARTS: Batteries, tape recorders.

WASTE ITEMS: See following table.

COMMENTS: Paper estimate based on 10 sheets ordinary paper, 8.5 x 11 inches. OMV waste (if any) not attributed to HST.

REFERENCES: MRDB, BDM Study, Customer Servicing Requirements Databook

ID#	Hardware	Procedure	Waste Item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
15	HST		lubricant tube	tube	36	TBD	TBD	TBD	S	
16	HST		cable covers	scraps, off-gas	36	TBD	TBD	TBD	S	
17	HST		mylar tape	scraps, off-gas	36	TBD	TBD	TBD	S	
18	HST		metal debris	filings, screws, etc.	36	TBD	TBD	TBD	S	
19	HST		non-metal debris	clothing fibers, etc.	36	TBD	TBD	TBD	S	
20	HST		optical glass	small fragments	36	TBD	TBD	TBD	S	
21	HST		paper	notes during IVA rep.	3	TBD	TBD	TBD	S	

7.5 Free-flyers and Co-orbiting Platforms

7.5.4 SAAX 0013 — Gamma Ray Observatory (GRO) Servicing

MISSION CONTACT(S): Eugene Humphrey (GSFC)*

MISSION DESCRIPTION: Free-flying celestial pointer, 400 km 28.5^{o} orbit. Integrated science experiments and spacecraft. Four science experiments, propulsion subsystem (hydrazine), solar arrays and hi-gain antenna, modules from MMS (2 power modules, 1 C&DH module).

OPERATIONAL LIFETIME: 4.5 years.

SERVICING/MAINTENANCE INTERVAL: 27 months.

SERVICING SCENARIO

EVA: After retrieval by OMV, failed/malfunctioning subsystems replaced in servicing bay, hydrazine tanks refueled (1230 kg) in refueling bay. One of the four experiments may be upgraded by change-out. Refurbished GRO tested and reorbited.

IVA: No contingency repairs of science experiments planned.

COMMON HARDWARE: MMS-type modules (C&DH, MPS); solar arrays, high-gain antennas.

EXPERIMENT PAYLOADS: Science instruments.

CONSUMABLES: Hydrazine (1800 kg).

LIMITED LIFE PARTS: Batteries (in power module), tape recorders (C&DH module).

WASTE ITEMS: Quantified data not available.

COMMENTS: Refueling uses OSCAR interface; no spillage anticipated. Only one science experiment (BATSE) capable of orbital removal for contingency repairs. Access to experiments requires careful removal of thermal covers/insulation to prevent tearing of same.

REFERENCES: BDM Study, MRDB, Customer Servicing Requirements Databook

82

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7.5 Free-flyers and Co-orbiting Platforms

7.5.5 SAAX 0017 — Advanced X-ray Astronomy Facility (AXAF) Mission

MISSION CONTACT(S): Arthur Fuchs (HQ)*

MISSION DESCRIPTION: The AXAF is an observatory-class instrument with a number of focal plane instruments for the study of the universe at X-ray wavelengths. AXAF will have advanced capabilities in energy range, sensitivity, angular range, and mission lifetime. AXAF is a candidate for a payload on a Space Station platform, where spacecraft and instrument modules will be replaced at regularly scheduled intervals.

OPERATIONAL LIFETIME: 15 years.

SERVICING/MAINTENANCE INTERVAL: 3 years.

SERVICING SCENARIOS:

EVA: Remove/replace instruments or components from AXAF or MMS-type free flyer bus.

IVA: Monitor EVA, operate OMV, repair instruments.

COMMON HARDWARE: None identified.

EXPERIMENT PAYLOADS: X-ray telescope, mirrors, Charged Coupling Device Imaging Spectrometer, crystal spectrometer, high- and low-energy transmission grating spectrometers, high resolution camera, X-ray spectrometer.

CONSUMABLES: Cryogens for cooling (liquid helium), tape.

LIMITED LIFE PARTS: Tape recorders.

WASTE ITEMS: See following table.

COMMENTS: Instruments contain Ar-Xe-CO_2 mixture. An experiment is currently being planned to design a cryogen container. Martin Marietta was selected to build the Charged Coupling Device Imaging Spectrometer as a prime contractor to the Center for Space Research of MIT, a principal investigator for AXAF. (AW&ST, Oct. 20,1986)

REFERENCES: MRDB, BDM Study, Customer Servicing Requirements Databook

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SAAX 0017 -- ADVANCED X-RAY ASTRONOMY FACILITY

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
23	Bragg Crystal Spect.		mixed gases	venting	36	TBD	TBD	TBD	G	
24	X-ray Spectrometer		helium		36	TBD	TBD	TBD	G	
25	X-ray Spectrometer		helium container	container	36	TBD	TBD	TBD	S	

7.5 <u>Free-flyers and Co-orbiting Platforms</u>

7.5.6 SAAX 0017A — Advanced X-ray Astronomy Facility (AXAF) Servicing

MISSION CONTACT(S): Arthur Fuchs (HQ)*

MISSION DESCRIPTION: Replace and upgrade instruments and subsystem modules and resupply consumables (cryogen).

OPERATIONAL LIFETIME: N/A

SERVICING/MAINTENANCE INTERVAL: 3 years.

SERVICING SCENARIOS:

EVA: Remove/replace instruments or components from AXAF or MMS-type free flyer bus.

IVA: Monitor EVA, operate OMV, repair instruments.

COMMON HARDWARE: None identified.

EXPERIMENT PAYLOADS: X-ray telescope, mirrors, Charged Coupling Device Imaging Spectrometer, crystal spectrometer, high- and low-energy transmission grating spectrometers, high resolution camera, X-ray spectrometer.

CONSUMABLES: Cryogens for cooling (liquid helium), tape.

LIMITED LIFE PARTS: Tape recorders.

WASTE ITEMS: Quantified data not available.

COMMENTS: Instruments contain Ar-Xe-CO_2 mixture.

REFERENCES: MRDB, BDM Study, Customer Servicing Requirements Databook

7.5 Free-flyers and Co-orbiting Platforms

7.5.7 SAAX 0022 — Space Station Spartan (SSS) Mission

MISSION CONTACT(S): John H. Lane (GSFC)*, Len Arnowitz (GSFC)

MISSION DESCRIPTION: An enhanced Spartan-class carrier provides the capability to co-orbit small and medium payloads for periods up to about 3 months at relatively low cost. Spartan is an autonomous spacecraft, and will co-orbit astrophysics and space science payloads. Following missions lasting up to 3 months, payloads may be returned to earth or stored at the Space Station for reflight missions. The spacecraft (i.e. the SS Spartan) will remain at the SS, have its payload (instrument) changed, and perform a new mission. This process will be continual.

OPERATIONAL LIFETIME: The operational lifetime of the spacecraft is TBD but on the order of several years, when it will be returned to earth for major refurbishment. Spacecraft repairs (subsystem module replacements primarily) can be carried out at the Space Station as required.

SERVICING/MAINTENANCE INTERVAL: 1 to 3 months; we estimate a maximum of one flight each quarter.

SERVICING SCENARIOS:

EVA: Replace instruments or spacecraft modules; resupply propellant from SS reservoir, reorient solar arrays.

IVA: Monitor EVA; retrieve and redeploy Spartan with help of OMV or other method to deploy/retrieve if OMV not available.

COMMON HARDWARE: None identified.

EXPERIMENT PAYLOADS: Various science instruments--initally, astrophysics and solar physics.

CONSUMABLES: Hydrazine (375 kg maximum).

LIMITED LIFE PARTS: Rechargeable batteries, solar array.

WASTE ITEMS: Quantified data not available.

COMMENTS: May use cold gas propellant instead of hydrazine if missions are short-duration (approximately 1-2 weeks).

REFERENCES: MRDB, BDM Study, "Space Station Spartan Study Final Report", NASA TM 86215, John H. Lane et al., July 1985, Customer Servicing Requirements Databook

7.5 Free-flyers and Co-orbiting Platforms

7.5.8 S.' \X 0022A — Space Station Spartan (SSS) Servicing

MISSION CONTACT(S): John H. Lane (GSFC)*, Len Arnowitz (GSFC)

MISSION DESCRIPTION: Maintain the carrier and replace the scientific payload for the next mission.

OPERATIONAL LIFETIME: N/A

SERVICING/MAINTENANCE INTERVAL: 1 to 3 months; estimated maximum of one flight each quarter.

SERVICING SCENARIOS:

EVA: Replace instruments or spacecraft modules; resupply propellant from SS reservoir, reorient solar arrays.

IVA: Monitor EVA; retrieve and redeploy Spartan with help of OMV or other method to deploy/retrieve if OMV not available.

COMMON HARDWARE: See following table.

EXPERIMENT PAYLOADS: Various science instruments--initally, astrophysics and solar physics.

CONSUMABLES: Hydrazine (375 kg maximum).

LIMITED LIFE PARTS: Rechargeable batteries, solar array.

WASTE ITEMS: See following table.

COMMENTS: May use cold gas propellant instead of hydrazine if missions are short-duration (approximately 1-2 weeks).

REFERENCES: MRDB, BDM Study, "Space Station Spartan Study Final Report", NASA TM 86215, John H. Lane et al., July 1985, Customer Servicing Requirements Databook

SAAX 0022A -- SPACE STATION SPARTAN SERVICING

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
29	SS Spartan Spacecraft	refueling	hydrazine	refueling leakage	3	TBD	TBD	TBD	G,L	C,F,T

7.5 Free-flyers and Co-orbiting Platforms

7.5.9 SA AX 0027 — Explorer 1 (EX1) Servicing (Solar Max Mission)

MISSION CONTACT(S): Ken Rosette (GSFC)*

MISSION DESCRIPTION: Scientific instrument(s) mounted on Explorer platform. Explorer incorporates the 3-module MMS (ACM, C&DH, power) plus the Explorer payload equipment deck (6 compartments) and instrument interface connector plate. (This is upgraded configuration relative to the STS SMM.)

OPERATIONAL LIFETIME: Nine years.

SERVICING/MAINTENANCE INTERVAL: Maint. scheduled every 3 years in MRDB, but data provided by Rosette assumes a servicing interval of 2 years.

SERVICING SCENARIO

EVA: Contingency only; EVA activities such as instrument/module change-out planned to be performed by remote manipulation from inside pressurized module. Estimated elapsed time per episode is 1 week.

IVA: Operate remote manipulator, change out modular units, including science instruments, no plans for repair other than replacement on-orbit.

COMMON HARDWARE: Spacecraft assembly.

EXPERIMENT PAYLOADS: Solar Maximum instrument package.

CONSUMABLES: None aboard spacecraft bus (MMS portion); current SMM instrument package includes an X-Ray Polarimeter (XRP) which has about 10 kg. propane on board for purging.

LIMITED LIFE PARTS: Batteries and tape recorders.

WASTE ITEMS: See following table.

COMMENTS: Waste items are contingent quantities derived from experience with SMM repair on STS mission. Next generation SMM (Max 91) will include more instruments. Servicing, on-orbit assembly and check-out operations for this package may generate TBD waste. Possibility of a power module with fuel tank changed out in its entirety rather than recharged.

REFERENCES: MRDB, BDM Study, "Multimission Modular Spacecraft (MMS) Systems Specifications", S-700-10 Revision A, Goddard SFC, April 1986, Customer Servicing Requirements Databook

ID#	Hardware	Procedure	Waste item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
30	Explorer Platform	SMM Bus	wipes	10 wipes	24	1	0.3	TBD	S	F
31	ACS/ MPS/C&DH Mods.	SMM Bus	grease solvent	per changeout	24	10	TBD	TBD	L	F
32	ACS/ MPS/C&DH Mods.	SMM Bus	thermal grease	per changeout	24	2	0.2	TBD	S	
33	ACS/ MPS/C&DH Mods.	SMM Bus	gloves	pair	24	4	0.08	0.4	S	F
34	X-Ray Polarimeter	SMM Payload	propane	purge	24	1	10	27	L	
35	Cover & Mountings	SMM Payload	thermal blanket	scrap	24	1	0.05	2.7	S	
36	Cover & Mountings	SMM Payload	kapton tape	scrap	24	10	0.2	1	S	
37	Cover & Mountings	SMM Payload	screws	screw	24	20	TBD	TBD	S	
38	Cover & Mountings	SMM Payload	tywraps	tywrap	24	5	TBD	TBD	S	
39	Cover & Mountings	SMM Payload	washers	washer	24	20	TBD	TBD	S	

7.5 Free-flyers and Co-orbiting Platforms

7.5.10 SAAX 0028 — Explorer 2 Servicing (EX2)

MISSION CONTACT(S): William Hibbard (GSFC)*

MISSION DESCRIPTION: Explorer platforms support low-cost missions for special astrophysics, space plasma physics, and atmospheric investigations from space. Payloads are TBD.

OPERATIONAL LIFETIME: 10 years

SERVICING/MAINTENANCE INTERVAL: 3 years (approximately).

SERVICING SCENARIOS:

EVA: Change out instruments, other components, MMS-type modules.

IVA: Monitor EVA, operate OMV, repair instruments.

COMMON HARDWARE: See following table.

EXPERIMENT PAYLOADS: Various astrophysics instruments.

CONSUMABLES: TBD (MMS-type propellants)

LIMITED LIFE PARTS: Batteries, tape recorders (for example)

WASTE ITEMS: See following table.

COMMENTS: "Explorer" is a name for a package of science instruments mounted on an MMS-type spacecraft bus. Comparable to SMM. Spacecraft will reside at Space Station for 7 days when being serviced.

REFERENCES: MRDB, BDM Study

SAAX 0028 AND SAAX 0029 -- EXPLORERS 2 AND 3 SERVICING

ID#	Hardware	Procedure	Waste Item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
40	Spacecraft propulsion		propellant-nature TBD	refuel leakage	36	TBD	TBD	TBD	L,G	
41	Spacecraft modules		thermal blanketing	scraps	36	TBD	TBD	TBD	S	
42	Spacecraft propulsion		propellant-nature TBD	refuel leakage	36	TBD	TBD	TBD	L,G	
43	Spacecraft modules		thermal blanketing	scraps	36	TBD	TBD	TBD	S	

7.5 Free-flyers and Co-orbiting Platforms

7.5.11 SAAX 0029 — Explorer 3 Servicing (EX3)

MISSION CONTACT(S): William Hibbard (GSFC)*

MISSION DESCRIPTION: Explorer platforms support low-cost missions for special astrophysics, space plasma physics, and atmospheric investigations from space. Payloads are TBD.

OPERATIONAL LIFETIME: 10 years

SERVICING/MAINTENANCE INTERVAL: 3 years.

SERVICING SCENARIOS:

EVA: Change out instruments, other components, MMS-type modules.

IVA: Monitor EVA, operate OMV, repair instruments.

COMMON HARDWARE: See following table.

EXPERIMENT PAYLOADS: Various astrophysics instruments.

CONSUMABLES: TBD (MMS-type propellants).

LIMITED LIFE PARTS: Batteries, tape recorders (for example).

WASTE ITEMS: See following table.

COMMENTS: "Explorer" is a name for a package of science instruments mounted on an MMS-type spacecraft bus. Comparable to SMM. Spacecraft will reside at Space Station for 7 days when being serviced.

REFERENCES: MRDB, BDM Study

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7.5 Free-flyers and Co-orbiting Platforms

7.5.12 SAAX 0207J — Recoverable Plasma Diagnostic Package (RPDP)

MISSION CONTACT(S): Roger F. Randall (U. Iowa)*

MISSION DESCRIPTION: An ejectable/recoverable satellite with flight and ground support containing particle and field diagnostic instruments and official sensors to study dynamics of the natural environment and perturbations from particle beams.

OPERATIONAL LIFETIME: 5 years.

SERVICING/MAINTENANCE INTERVAL: 6 months.

SERVICING SCENARIOS:

EVA: Retrieve RPDP (from STS or OMV) and move inside SS. Return RPDP to OMV or STS for redeployment.

IVA: Replace batteries, components (contingency), instruments in pressurized module.

COMMON HARDWARE: Dedicated experiment processor and RF antennas (latter mounted on SS).

EXPERIMENT PAYLOADS: Plasma wave/DC electric field instrument, plasma analyser system, ion mass spectrometer, retarding potential analyser, Langmuir probe, high frequency sounder system, magnetometer.

CONSUMABLES: None.

LIMITED LIFE PARTS: Batteries, optical windows, other components not identified.

WASTE ITEMS: See following table.

COMMENTS: May be tethered or spun off from MRMS — RPDP has no on-board propulsion system. As co-orbiter, would be stationed 200 km from SS. Orbit adjustment every 6 months.

REFERENCES: MRDB, BDM Study, Payload Database (TRW), GSFC Miniworkshop Report, SAIC Operational Scenario for STO.

SAAX 0207J -- RECOVERABLE PLASMA DIAGNOSTIC PACKAGE

ID#	Hardware	Procedure	Waste Item	Unit	SI	#/SI	kg/SI	ltr/SI	Phase	Code
59	Batteries		gases	batt off-gas	6	1	3.2	2240	G	
60	Batteries		depleted batteries	battery	6	1	181	69.76	S	

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8.0 ACKNOWLEDGEMENTS

The ARC team gratefully acknowledges the contributions of several individuals whose guidance and support made the study possible, and helped bring it to a successful conclusion on time and within budget. Particular thanks go to Larry Chambers and Paula Burnett at NASA Headquarters, and to Gary Musgrave of GE/MATSCO. Dr. John Hilchey and Danny Xenofos at Marshall Space Flight Center supported and advised the ARC team in many special ways. Dr. Neal Maresca of BDM Corporation and his NASA contract monitor, Dr. George Newton, were extremely helpful in advising on general study methods as well as specific mission servicing issues. Finally, the study team recognizes that the high quality of the data it compiled is due to the outstanding cooperation and patience of all the OSSA mission data sources listed in Appendix A-4 who gave generously of their precious time on numerous occasions.

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APPENDIX A-1. <u>Request for Information (RFI) Form & Waste Data Sheet (WDS)</u>

The first task undertaken by the ARC study team after obtaining authorization to proceed was to design a Request for Information (RFI) and associated Waste Data Sheet (WDS). The RFI was intended to be sent to potential data sources, to inform them of study objectives, provide a definition of "waste material" and define data categories. Initially, the team intended to use the RFI/WDS combination as a stand-alone mail questionnaire package for data collection. Two major considerations altered that intent. First, the BDM project leadership told the ARC team that they had had poor response to a mailed questionnaire in collecting their data, and found that personal visits were required in order to complete collection of their servicing data. They recommended that the ARC study team go directly to a personal interview method, particularly in view of the relatively short time frame for the ARC study.

Second, preliminary conversations with OSSA mission specialists representing many different scientific and engineering disciplines indicated that it would be extremely difficult to create a universally applicable, yet simple mail questionnaire in the time available.

The ARC team therefore decided to draft an RFI/WDS that would be aimed toward sensitizing mission specialists to waste-related issues, and to help them organize their thinking on the topic. This package would be mailed to them, and after they had had some time to evaluate their mission for waste production potential, an interview would be conducted during which the visiting ARC team member would take structured notes on the WDS. On the same visit, the interviewer picked up any supplementary documents that might elaborate on the bare-bones data obtained. Many valuable draft documents were collected that might not have been sent back with a mail questionnaire, because they were informal working papers.

Although the initial RFI/WDS package included in this Appendix did not cover all the issues eventually identified in the study , it served its purpose of sensitizing respondents and structuring the interviews. In the following subsections, the rationale behind the RFI/WDS package is described. Some of the thinking that really evolved from use of the RFI/WDS is also included, even though this is not captured in the documents themselves, because these updated concepts were indeed used in follow-up phone calls to clarify and enrich the intial data set that the RFI/WDS stimulated.

A-1.2 <u>Waste Related to Hardware and Procedures</u>

A systematic evaluation of experimental operations and servicing procedures and associated hardware would be the ideal approach to identifying OSSA mission waste. These operations and procedures ultimately "generate" the waste which will require containment, transport, processing and/or disposal. However, because most mission experiments have yet to be formally proposed, this could not be done in constructing the RFI and WDS. Instead, generalized mission hardware and associated servicing procedures were used in combination to frame many questions about waste material.

The BDM Study included lists of serviceable mission hardware items which they designated as Orbital Servicing Units (OSU's). These lists were a good starting point for conceptualizing the possible variety of hardware items that might associated with waste production when the database was designed, and were useful "prompts" during interviews and subsequent telephone calls. They also were included in the Mission Waste Profiles if they were associated with significant waste production.

The servicing procedures scenario given for each mission in BDM Study contains two sections 2.2 and 2.3 named "Planned Orbital Servicing Activities" and "Contingency Orbital Servicing Activities" respectively. These were also evaluated for the potential to produced waste items. The procedures identified as major potential waste sources are described as EVA and IVA procedures in our Mission Waste Profiles.

A-1.3 Waste Linked to Consumables

The BDM Study and other documents conceptually link waste to mission consumables as well as harware and procedures. In this perspective, what is consumed is transformed to some product(s) which may be useful and/or non-useful (i.e. waste). This potential waste source was described in BDM Study section 1.6, "Consumables and Limited Life Parts" for each mission. For example, this section for the ASO/SOT mission listed consumables as "film for photometric filtergraph" and limited life parts as "none identified".

Exposed film could be considered as a waste item by strictly applying our proposed waste definition of "an item no longer useful in its present form". However, since exposed film generally contains mission "data", for this study it was not classified as waste. Failed components could also be categorized as waste.

A second potential source of waste data was identified in BDM Study section 3.2 (b) where, for some missions, total consumables were estimated as total mass (kg). For the same ASO/SOT mission example, this value was "20 kg".

At the current stage in mission experiment development, it has not been possible to clearly separate useful from non-useful end-products. It was therefore assumed for this study that the major portion of consumables would be ultimately converted to non-useful end products. The exceptions to this were experiment-related samples or data which would require analysis (on-orbit or on the ground) as part of a mission. These items were sequestered in the database and not included as waste.

REQUEST FOR INFORMATION AND WASTE DATA SHEET

SPACE STATION MISSION DATA
WASTE MANAGEMENT REQUIREMENTS ASSESSMENT

INSTRUCTIONS

Step 1. Specify one currently-planned mission on each **DATA SHEET**. Focus on missions where significant waste may be generated. List documents relevant to understanding the mission on the **SUPPORTING DOCUMENTS** page.

Step 2. List experiment names and hardware items (if applicable). Indicate specific waste items, i.e. syringes, gloves, solvents, etc. Group similar waste items together — solids, corrosives, etc. — if this is convenient.

Step 3. Estimate daily units per item. A unit is equivalent to a specific waste item. Units are totaled for each day any waste item is generated to get daily units. Indicate mass (gm) and volume (cc) estimates for a single item (unit). Enter a range of values if data lacks specificity, and note how the range was established.

Step 4. Estimate number of days per 90-day mission when a particular waste item will be produced. A range is acceptable. Here is an example of applying Steps 3 and 4. An experiment will use 2 pairs of vinyl gloves on any day that it is being carried out, and there will be 7 such days per 90-day mission. Opposite "gloves, vinyl" in Column 3, the DU entry would be "2" and the Days per mission entry, "7".

Step 5. Enter codes for the hazardous qualities (if any) for each item in the Codes column. Codes are:

B=Bioactive
C=Corrosive
F=Flammable/Combustible
R=Radioactive
T=Toxic

Step 6. Annotate your entries, such as the basis of your estimates (formulas, assumptions) as aids for later reviews and discussions.

Data sheet

Mission designation SAAX: ______________________

Mission name: ______________________

Mission module volume (rack equivalents): ______________________

Experiment	Hardware item	Waste item	DUs*	Waste item mass (gm)	Waste item volume (cc)	Days per mission**	Codes:	Notes

*DU = daily units: these are the number of waste item units per day when produced

**Number of days on which waste is produced per 90 day mission

APPENDIX A-2. Waste Database Elements

The name of the column element on the following spreadsheets is printed in **boldface** and a short description of that column follows each.

Column #

1. **ID#**: A number randomly assigned to each waste entry.

2. **Mission Number**: Mission number.

3. **Type**: Whether mission is a Lab Module mission (LM), an External Attached Payload (PL) or a Free-flier/Co-orbiting Platform (FF).

4. **Acronym**: Commonly used acronym of mission name.

5. **Mission Name**: Mission name.

6. **Hardware**: Piece of hardware with which waste item is associated, if applicable.

7. **Procedure**: Procedure which produces waste, if applicable.

8. **Waste Item**: Item or material being evaluated.

9. **Unit**: Number of items or amount of material designated "one unit".

10. **SI**: Servicing interval for that particular waste item on that mission.

11. **Units/day or run**: Where applicable, number of units produced per day or per run of an experiment.

12. **Days or runs/90 days**: Where applicable, number of days per 90 days on which waste is produced, or number of runs of an experiment completed in 90 days.

13. **#/SI**: Number of units produced per servicing interval (as shown in Column 10).

14. **av. kg**: Average kilograms per unit (given only for some items).

15. **av. ltr**: Average liters per unit (given only for some items).

16. **kg/SI**: Total kilograms per servicing interval of that waste item.

17. **ltr/SI**: Total liters per servicing interval of that waste item.

18. **min cc**: For items where a range was listed for the volume, the lower figure, shown in cubic centimeters.

19. **max cc**: For items where a range was listed for the volume, the higher figure, shown in cubic centimeters.

20. **avg cc/unit**: Average volume per unit, shown in cubic centimeters.

21. **min gm**: For items where a range was listed for the mass, the lower figure, shown in grams.

22. **max gm**: For items where a range was listed for the mass, the higher figure, shown in grams.

23. **avg gm/unit**: Average mass per unit, shown in grams.

24. **liters/run**: Liters of waste item produced per run of an experiment.

25. **kg/run**: Kilograms of waste item produced per run of an experiment.

26. **Phase**: Whether waste is solid, liquid, or gas.

27. **Code**: Handling code for waste: B=bioactive; C=corrosive; F=flammable; R=radioactive; S=sharp; T=toxic.

28. **Contact**: Primary person who provided information and reviewed mission profile.

29. **Center**: Institutional affiliation.

30. **Notes**: Notes on database material relating to that waste item.

OSSA MISSIONS WASTE INVENTORY DATABASE (10/86)

1	1	2	3	4	5	6	7	8	9
1	1	SAAX 0001	PL	CRNE	Cosmic Ray Nuclei Experiment			none	
2	2	SAAX 0004	FF	SIRTF	Space Infrared Telescope Facility	SIRTF		dewar flask	flask
3	3	SAAX 0004A	FF	SIRTF	Space IR Telescope Servicing	SIRTF Observatory	storage venting	gaseous He	storage vent
4	4	SAAX 0004A	FF	SIRTF	Space IR Telescope Servicing	Transfer Dewar	storage venting	gaseous He	storage vent
5	5	SAAX 0004A	FF	SIRTF	Space IR Telescope Servicing	Transfer Dewar	recharge venting	gaseous He	recharg vent
6	6	SAAX 0004A	FF	SIRTF	Space IR Telescope Servicing	SIRTF Observatory	recharge venting	gaseous He	recharg vent
7	7	SAAX 0010	PL	ASO/HRSO	Advanced Solar Observ/High Res Solar Tele	HRSO	ASO	paper	5-10 of 8.5 x 11
8	8	SAAX 0010	PL	ASO/HRSO	Advanced Solar Observ/High Res Solar Tele	HRSO	ASO	paper	sht chrt/plot paper
9	9	SAAX 0010A	PL	ASO/HRSO	HRSO Servicing	HRSO	ASO	inert gas	purge
10	10	SAAX 0010A	PL	ASO/HRSO	HRSO Servicing	HRSO	ASO	thermal blanket	scraps
11	11	SAAX 0010A	PL	ASO/HRSO	HRSO Servicing	HRSO	ASO	tape	scraps
12	12	SAAX 0011	PL	ASO/POF	Advanced Sol Observ/Pinhole Occulter Fac.	Electronics		failed components	component
13	13	SAAX 0011	PL	ASO/POF	Advanced Sol Observ/Pinhole Occulter Fac.	Control/Display		paper	10 sheets
14	14	SAAX 0011A	PL	ASO/POF	ASO/POF Servicing			none	
15	15	SAAX 0012	FF	HST	Hubble Space Telescope	HST		lubricant tube	tube
16	16	SAAX 0012	FF	HST	Hubble Space Telescope	HST		cable covers	scraps, off-gas
17	17	SAAX 0012	FF	HST	Hubble Space Telescope	HST		mylar tape	scraps, off-gas
18	18	SAAX 0012	FF	HST	Hubble Space Telescope	HST		metal debris	filings, screws, etc
19	19	SAAX 0012	FF	HST	Hubble Space Telescope	HST		non-metal debris	clothing fibers, etc
20	20	SAAX 0012	FF	HST	Hubble Space Telescope	HST		optical glass	small fragments
21	21	SAAX 0012	FF	HST	Hubble Space Telescope	HST		paper	notes/IVA repair
22	22	SAAX 0013	FF	GRO	Gamma Ray Observatory			none	
23	23	SAAX 0017	FF	AXAF	Advanced Xray Astrophysics Facility	Bragg Crystal Spect		mixed gases	venting
24	24	SAAX 0017	FF	AXAF	Advanced Xray Astrophysics Facility	Xray Spectrometer		helium	
25	25	SAAX 0017	FF	AXAF	Advanced Xray Astrophysics Facility	Xray Spectrometer		helium container	container
26	26	SAAX 0017A	FF	AXAF	Advanced Xray Astrophysics Fac Servicing			none	
27	27	SAAX 0021	PL	SMF	Superconducting Magnet Facility	Cooling System	SMF	helium	spillage
28	28	SAAX 0022	FF	SSS	Space Station Spartan			none	
29	29	SAAX 0022A	FF	SSS	SSS Servicing	SS Spartan Spacecraft	Refueling	hydrazine	refuel leakage
30	30	SAAX 0027	FF	EXP1	Explorer 1 (Solar Max Mission Servicing)	Explorer Platform	SMM Bus	wipes	10 wipes
31	31	SAAX 0027	FF	EXP1	Explorer 1 (Solar Max Mission Servicing)	Mod (ACS, MPS, C&DH)	SMM Bus	solvent	for grease
32	32	SAAX 0027	FF	EXP1	Explorer 1 (Solar Max Mission Servicing)	Mod (ACS, MPS, C&DH)	SMM Bus	thermal grease	per inst. change
33	33	SAAX 0027	FF	EXP1	Explorer 1 (Solar Max Mission Servicing)	Mod (ACS, MPS, C&DH)	SMM Bus	gloves	pair
34	34	SAAX 0027	FF	EXP1	Explorer 1 (Solar Max Mission Servicing)	X-Ray Polarimeter	SMM Payload	propane	purge
35	35	SAAX 0027	FF	EXP1	Explorer 1 (Solar Max Mission Servicing)	Cover & Mountings	SMM Payload	thermal blanket	scrap
36	36	SAAX 0027	FF	EXP1	Explorer 1 (Solar Max Mission Servicing)	Cover & Mountings	SMM Payload	kapton tape	scrap
37	37	SAAX 0027	FF	EXP1	Explorer 1 (Solar Max Mission Servicing)	Cover & Mountings	SMM Payload	screws	screw
38	38	SAAX 0027	FF	EXP1	Explorer 1 (Solar Max Mission Servicing)	Cover & Mountings	SMM Payload	tywraps	tywrap
39	39	SAAX 0027	FF	EXP1	Explorer 1 (Solar Max Mission Servicing)	Cover & Mountings	SMM Payload	washers	washer
40	40	SAAX 0028	FF	EXP2	Explorer 2	Spacecraft propulsion		propellant-nature TBD	refuel leakage
41	41	SAAX 0028	FF	EXP2	Explorer 2	Spacecraft modules		thermal blanketing	scraps
42	42	SAAX 0029	FF	EXP3	Explorer 3	Spacecraft propulsion		propellant-nature TBD	refuel leakage
43	43	SAAX 0029	FF	EXP3	Explorer 3	Spacecraft modules		thermal blanketing	scraps
44	44	SAAX 0030	PL	HH1	Space Station Hitchhiker 1			none	
45	45	SAAX 0031	PL	HH2	Space Station Hitchhiker 2			none	
46	46	SAAX 0032	PL	HH3	Space Station Hitchhiker 3			none	
47	47	SAAX 0112	PL	CDCE	Cosmic Dust Collection Experiment	Electronics		failed component	component
48	48	SAAX 0115	PL	AT	Astrometric Telescope — Extrasolar			none	
49	49	SAAX 0207	PL	STO	Solar Terrestrial Observatory			none (see sub-miss)	
50	50	SAAX 0207A	PL	ACRIM	Active Cavity Radiometer Irradiance Monitor			none	
51	51	SAAX 0207C	PL	HRTS	Solar UV High Res Telescope/Spectrograph	Control Workstation		paper	5 sheets

OSSA MISSIONS WASTE INVENTORY DATABASE (10/86)

1	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1																			V. Jones	HQ
2	24			TBD			2355.00	7000									S		C. Wiltsee	ARC
3	24			1	7.7	43,300	7.74	43300			4E+07			7741			G		C. Wiltsee	ARC
4	24			1	46	257,000	46.00	257000			3E+08			46000			G		C. Wiltsee	ARC
5	24			1	145	812,000	145.00	812000			8E+08			145000			G		C. Wiltsee	ARC
6	24			1	34	190,000	34.00	190000			2E+08			34000			G		C. Wiltsee	ARC
7	3	1	90	45	0	0.059	1.69	2.66	25	50	59			37.5			S		G. Epstein	GSFC
8	3	10	90	450	0	0.0077	2.25	3.47	25	50	7.7			5			S		G. Epstein	GSFC
9	12			TBD			TBD	TBD									G		G. Epstein	GSFC
10	12			TBD			TBD	TBD									S		G. Epstein	GSFC
11	12			TBD			TBD	TBD									S		G. Epstein	GSFC
12	60			TBD			TBD	TBD									S		H. Hudson	UCSD
13	3			90	0.1	0.077	4.50	6.93			77			50			S		H. Hudson	UCSD
14																			H. Hudson	UCSD
15	36			TBD			TBD	TBD									S		J. Welch	HQ
16	36			TBD			TBD	TBD									S		J. Welch	HQ
17	36			TBD			TBD	TBD									S		J. Welch	HQ
18	36			TBD			TBD	TBD									S		J. Welch	HQ
19	36			TBD			TBD	TBD									S		J. Welch	HQ
20	36			TBD			TBD	TBD									S		J. Welch	HQ
21	3			TBD			TBD	TBD									S		J. Welch	HQ
22	27						0.00	0.00											E. Humphrey	GSFC
23	36	1	TBD	TBD			TBD	TBD			6000						G		A. Fuchs	HQ
24	36	1	TBD	TBD			TBD	TBD			191						G		A. Fuchs	HQ
25	36			TBD			TBD	TBD									S		A. Fuchs	HQ
26	36						0.00	0.00											A. Fuchs	HQ
27	12			TBD			275.00	1540000									G		V. Jones	HQ
28	3						0.00	0.00											J.H.Lane	GSFC
29	3			TBD			TBD	TBD									G,L	C,F,T	J.H.Lane	GSFC
30	24			1	0.3		0.30	1.50						300			S	F	K. Rosette	GSFC
31	24			10			TBD	TBD									L	F	K. Rosette	GSFC
32	24			2	0.1		TBD	TBD						100			S		K. Rosette	GSFC
33	24			4	0	0.1	0.08	0.40			100			20			S	F	K. Rosette	GSFC
34	24			1	10	27	10.00	27.00			27000						L		K. Rosette	GSFC
35	24			1	0.1	2.7	0.05	2.70			2700			50			S		K. Rosette	GSFC
36	24			10	0	0.1	0.20	1.00			100			20			S		K. Rosette	GSFC
37	24			20			TBD	TBD									S		K. Rosette	GSFC
38	24			5			TBD	TBD									S		K. Rosette	GSFC
39	24			20			TBD	TBD									S		K. Rosette	GSFC
40	36			TBD			TBD	TBD									L,G		W. Hibbard	GSFC
41	36			TBD			TBD	TBD									S		W. Hibbard	GSFC
42	36			TBD			TBD	TBD									L,G		W. Hibbard	GSFC
43	36			TBD			TBD	TBD									S		W. Hibbard	GSFC
44	6						0.00	0.00											T. Goldsmith	GSFC
45	6						0.00	0.00											T. Goldsmith	GSFC
46	6						0.00	0.00											T. Goldsmith	GSFC
47	6			TBD			TBD	TBD									S		F. Horz	JSC
48	24						0.00	0.00											K. Nishioka	ARC
49	36						0.00	0.00											B. Roberts	MSFC
50	6						0.00	0.00											R. Willson	JPL
51	3			250	0	0.0385	18.00	27.20			38.5			25			S		G. Brueckner	NRL

1	30
1	
2	Dewar probably used by other astrophysics missions
3	Day/mo based on serv int=24 mo; cryo refuelperiod=14 days
4	
5	Cryogen transfer takes 4 hours every 2 years
6	
7	
8	
9	Nitrogen or argon purge when data not being collected
10	Scraps from instrument c/o every 6 months
11	Scraps from instrument c/o every 6 months
12	Too early to tell
13	10 sheets scrap paper
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	Possibly some on-orbit repair, but this is not planned
24	
25	Container currently under design
26	Possibly some on-orbit repair, but this is not planned
27	Resupply interval = 1 year
28	
29	leakage during refuel; would be refuel between each mission
30	Days/mission based on 1 wk/yr (7 days /8.1 cycles)
31	
32	
33	
34	STP
35	
36	
37	
38	
39	
40	
41	
42	
43	
44	No waste from HH's;paylds may generate waste but still TBD
45	
46	
47	Piecemeal changeout
48	
49	Will have internal-pres. mod. control work station-details TBD
50	
51	

1	1	2	3	4	5	6	7	8	9
52	52	SAAX 0207E	PL	SUSIM	Solar UV Spectral Irradiance Monitor			none	
53	53	SAAX 0207F	PL	SEPAC	Space Exp. with Particle Accelerators	Plasma source		argon	recharging
54	54	SAAX 0207F	PL	SEPAC	Space Exp. with Particle Accelerators	Plasma source		xenon	recharging
55	55	SAAX 0207F	PL	SEPAC	Space Exp. with Particle Accelerators	Electron guns		cathode element	element
56	56	SAAX 0207F	PL	SEPAC	Space Exp. with Particle Accelerators	Electron guns		batteries	battery
57	57	SAAX 0207G	PL	WISP	Waves in Space Plasma			none	
58	58	SAAX 0207H	PL	TEBPP	Theoretical and Exp Beam Plasma Physics	Detectors	Remove & replace	failed sensor head unit	unit
59	59	SAAX 0207J	PL	RPDP	Recoverable Plasma Diagnostic Package	Batteries		gases	batt off-gas
60	60	SAAX 0207J	PL	RPDP	Recoverable Plasma Diagnostic Package	Batteries		depleted batteries	battery
61	61	SAAX 0250	PL	ERBE	Hitchiker 4 — Earth Radiation			none	
62	62	SAAX 0251	PL	TRMM	Tropical Rainfall Mapping Mission			none	
63	63	SAAX 0307	LM	LSF	Life Sciences Lab	Multi-purp. work bnch		filters	filter
64	64	SAAX 0307	LM	LSF	Life Sciences Lab	Multi-purp. work bnch		trace contaminant	trace
65	65	SAAX 0307	LM	LSF	Life Sciences Lab	Multi-purp. work bnch		vent cannister	cannister
66	66	SAAX 0307	LM	LSF	Life Sciences Lab	Multi-purp. work bnch		absorbant pads	pad
67	67	SAAX 0307	LM	LSF	Life Sciences Lab	Multi-purp. work bnch		specimen	specimen
68	68	SAAX 0307	LM	LSF	Life Sciences Lab	Habitat		waste tray	tray
69	69	SAAX 0307	LM	LSF	Life Sciences Lab	Habitat		urine collector	collector
70	70	SAAX 0307	LM	LSF	Life Sciences Lab	Habitat		filters w/ charcoal	filter
71	71	SAAX 0307	LM	LSF	Life Sciences Lab	Habitat		feces	2 rat/week
72	72	SAAX 0307	LM	LSF	Life Sciences Lab	Habitat		urine	36 rat/week
73	73	SAAX 0307	LM	LSF	Life Sciences Lab	Habitat		evap. water	36 rat/day
74	74	SAAX 0307	LM	LSF	Life Sciences Lab	Habitat		spent nutrient	
75	75	SAAX 0307	LM	LSF	Life Sciences Lab	Centrifuge		waste tray	tray
76	76	SAAX 0307	LM	LSF	Life Sciences Lab	Centrifuge		urine collector	collector
77	77	SAAX 0307	LM	LSF	Life Sciences Lab	Centrifuge		filters w/ charcoal	filter
78	78	SAAX 0307	LM	LSF	Life Sciences Lab	Centrifuge		feces	2 rat/week
79	79	SAAX 0307	LM	LSF	Life Sciences Lab	Centrifuge		urine	16 rat/week
80	80	SAAX 0307	LM	LSF	Life Sciences Lab	Centrifuge		evap. water	16 rat/day
81	81	SAAX 0307	LM	LSF	Life Sciences Lab	Cage washer		water	cage wash
82	82	SAAX 0307	LM	LSF	Life Sciences Lab	Cage washer		detergent	cage wash
83	83	SAAX 0307	LM	LSF	Life Sciences Lab	Cage washer		filters	cage wash
84	84	SAAX 0307	LM	LSF	Life Sciences Lab	rodent		rodent	specimen
85	85	SAAX 0307	LM	LSF	Life Sciences Lab	plant		plant	plant
86	86	SAAX 0307	LM	LSF	Life Sciences Lab	habitat module		habitat module	module
87	87	SAAX 0307	LM	LSF	Life Sciences Lab	gloves		gloves	box of 50
88	88	SAAX 0307	LM	LSF	Life Sciences Lab	gowns		gowns	box of 25
89	89	SAAX 0307	LM	LSF	Life Sciences Lab	masks		masks	box of 25
90	90	SAAX 0307	LM	LSF	Life Sciences Lab	wipes, dry		wipes, dry	box
91	91	SAAX 0307	LM	LSF	Life Sciences Lab	wipes, wet		wipes, wet	box
92	92	SAAX 0307	LM	LSF	Life Sciences Lab	rodent food		rodent food	1 rat/day
93	93	SAAX 0307	LM	LSF	Life Sciences Lab	rodent water		rodent water	1 rat/day
94	94	SAAX 0307	LM	LSF	Life Sciences Lab	rodent oxygen		rodent oxygen	1 rat/day
95	95	SAAX 0307	LM	LSF	Life Sciences Lab	rodent carbon dioxide		rodent carbon dioxide	1 rat/day
96	96	SAAX 0307	LM	LSF	Life Sciences Lab	plant water		plant water	
97	97	SAAX 0307	LM	LSF	Life Sciences Lab	plant nutrients (dry)		plant nutrients (dry)	
98	98	SAAX 0307	LM	LSF	Life Sciences Lab	plant oxygen cylinder		empty container	
99	99	SAAX 0307	LM	LSF	Life Sciences Lab	plant carb diox cylinder		empty container	
100	100	SAAX 0307	LM	LSF	Life Sciences Lab	syringes, 12 ml		syringes, 12 ml	syringe
101	101	SAAX 0307	LM	LSF	Life Sciences Lab	needles, 20G, 1"		needles, 20G, 1"	needle
102	102	SAAX 0307	LM	LSF	Life Sciences Lab	ammonium heparin		ammonium heparin	ml

OSSA MISSIONS WASTE INVENTORY DATABASE (10/86)

1	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
52	6						0.00	0.00											G. Brueckner	NRL
53	36			1			TBD	TBD									G		J. L. Burch	SWRI
54	36			1			TBD	TBD									G		J. L. Burch	SWRI
55	36			1	11	1.178	11.00	1.18			1178			11000			S		J. L. Burch	SWRI
56	36			1	75	380	75.00	380.00			4E+05			75000			S		J. L. Burch	SWRI
57					0	0	0.00	0.00											W. W. Taylor	TRW
58	0			1	5	27	5.00	27.00			27000			5000			S		H. R. Anderson	SAIC
59	6			1	0.2	2181.5	3.20	2240.00	1E+06	3E+06	2E+06	71	240	155.5			G		R. Randall	U. IA
60	6			1	181	63.87	181.00	69.76			63870			181000			S		R. Randall	U. IA
61	6				0	0	0.00	0.00											R. Shiffer	HQ
62	36				0	0	0.00	0.00											G. North	GSFC
63	3	1	12	12	0.9	11.47	10.80	137.64			11470			900			S	B	C. Johnson	ARC
64	3	1	2	2	23	60.511	45.40	121.02			60511			22700			G	T	C. Johnson	ARC
65	3	1	2	2	2.3	5	4.60	10.00			5000			2300			S	B	C. Johnson	ARC
66	3	2	6	12	0.2	0.307	2.72	3.68			307			227			S	B	C. Johnson	ARC
67	3	10	3	30	0.4	0.9	0.00	0.00			900			400			S	B	C. Johnson	ARC
68	3	18	12	216	0.9	2	194.40	432.00			2000			900			S	B	C. Johnson	ARC
69	3	1	12	12	1	0.98	12.00	11.76			980	500	##	1000			S	B	C. Johnson	ARC
70	3	1	2	2	5.5	8	10.90	16.00			8000			5450			S	B,T	C. Johnson	ARC
71	3	18	12	216	0	0	21.20	0.00						49			S	B	C. Johnson	ARC
72	3	1	12	12	0.1	0	49.60	49.59						114.8			L	B	C. Johnson	ARC
73	3	1	12	12	0	0	77.76	77.76						24			L		C. Johnson	ARC
74	3	1	1	1	40	40	40.00	40.00			40000			40000			L	B	C. Johnson	ARC
75	3	8	12	96	0.9	2	86.40	192.00			2000			900			S	B	C. Johnson	ARC
76	3	1	12	12	1	0.98	12.00	11.76			980	500	##	1000			S	B	C. Johnson	ARC
77	3	1	2	2	5.5	8	10.90	16.00			8000			5450			S	B	C. Johnson	ARC
78	3	8	12	96	0	0	9.41	0.00						49			S	B	C. Johnson	ARC
79	3	1	12	12	0.1	0	22.00	22.04						114.8			L	B	C. Johnson	ARC
80	3	1	12	12	0	0	34.60	34.60						24			L		C. Johnson	ARC
81	3	1	1	1	41	41	41.00	41.00			41000			41000			L	B	C. Johnson	ARC
82	3	52	12	624	0	0	15.00	20.00			0	15	20	0	15		L	B	C. Johnson	ARC
83	3		13	13	0.2	3.8462	3.00	50.00			3846			230.77			S	B	C. Johnson	ARC
84	3			52			0.00	0.00						18200			S		C. Johnson	ARC
85	3			50			0.00	0.00									S		C. Johnson	ARC
86	3			18			300.00	1000.00									S		C. Johnson	ARC
87	3			5			2.50	12.00									S	B	C. Johnson	ARC
88	3			5			15.00	50.00									S	B	C. Johnson	ARC
89	3			5			0.50	10.00									S	B	C. Johnson	ARC
90	3			20			2.00	10.00									S	B	C. Johnson	ARC
91	3			20			2.00	30.00									S	B	C. Johnson	ARC
92	3			TBD			28.00	56.00									S		C. Johnson	ARC
93	3			TBD			44.90	44.90									L		C. Johnson	ARC
94	3			TBD			0.00	0.00									G		C. Johnson	ARC
95	3			TBD			168.50	85800									G		C. Johnson	ARC
96	3			TBD			400.00	400.00									L	B	C. Johnson	ARC
97	3			TBD			0.00	0.00									S		C. Johnson	ARC
98	3	1	1	1			5.00	2.70									S		C. Johnson	ARC
99	3	1	1	1			5.00	2.70									S		C. Johnson	ARC
100	3			80			0.80	5.00									S	B	C. Johnson	ARC
101	3			200			0.30	4.00									S	B	C. Johnson	ARC
102	3			100			0.10	0.10									L	B	C. Johnson	ARC

1	30
52	
53	Recharge of instrument—gas is ionized and released during exp
54	Recharge of instrument—gas is ionized and released during exp
55	Replace when contaminated — cylinder 15 cm x 10 cm diamete
56	(1 x .5 x .75 m) 300 NiCd cells
57	Very slow nitrogen leak — no servicing planned
58	No planned serv; replaced upon unplanned failure-irreg intvals
59	Hydrogen, oxygen, others; vented from AgZn batteries
60	Change out batteries every 6 months
61	
62	Free-flier or co-orbiter spacecraft to be selected Feb '87
63	
64	refurbish on ground
65	refurbish on ground
66	
67	freeze (treat as sample)
68	waste tray & feces (dehydrate or freeze)
69	bladder
70	self-contained/non-compactable
71	
72	assumes no recycling (worst case)
73	assumes no recycling (worst case)
74	both on & off centrifuge (assumes recycling)
75	waste tray & feces
76	bladder & urine
77	self-contained/non-compactable
78	
79	assumes no recycling (worst case)
80	assumes no recycling (worst case)
81	assumes recycling - this is 10% makeup
82	
83	
84	sample to be returned
85	sample to be returned
86	change 10 habitat modules/40 rats
87	
88	
89	
90	
91	
92	20% of total food is waste
93	20% of total water is waste
94	supplied by Space Station ECLSS
95	handled by Space Station ECLSS
96	recycling assumed
97	incorporated into plants
98	
99	
100	
101	
102	

OSSA MISSIONS WASTE INVENTORY DATABASE (10/86)

1	1	2	3	4	5	6	7	8	9
103	103	SAAX 0307	LM	LSF	Life Sciences Lab	centrifuge tubes, 5 ml		centrifuge tubes, 5 ml	tubes
104	104	SAAX 0307	LM	LSF	Life Sciences Lab	syringes, 1 ml		syringes, 1 ml	syringe
105	105	SAAX 0307	LM	LSF	Life Sciences Lab	parafilm, 4" wide		parafilm, 4" wide	roll
106	106	SAAX 0307	LM	LSF	Life Sciences Lab	microhematocrit tubes		microhematocrit tubes	tube
107	107	SAAX 0307	LM	LSF	Life Sciences Lab	mini-capil tube sealant		capillary tube sealant	tube
108	108	SAAX 0307	LM	LSF	Life Sciences Lab	tube, 10 ml		tube, 10 ml	tube
109	109	SAAX 0307	LM	LSF	Life Sciences Lab	syringes, 2 ml		syringes, 2 ml	syringe
110	110	SAAX 0307	LM	LSF	Life Sciences Lab	gloves		gloves	box of 50
111	111	SAAX 0307	LM	LSF	Life Sciences Lab	gowns		gowns	box of 25
112	112	SAAX 0307	LM	LSF	Life Sciences Lab	masks		masks	box of 25
113	113	SAAX 0307	LM	LSF	Life Sciences Lab	petri dish, 60 mm dia.		petri dish, 60 mm dia.	dish
114	114	SAAX 0307	LM	LSF	Life Sciences Lab	petri dish, 100 mm dia.		petri dish, 100 mm dia.	dish
115	115	SAAX 0307	LM	LSF	Life Sciences Lab	beaker, 50 ml		beaker, 50 ml	beaker
116	116	SAAX 0307	LM	LSF	Life Sciences Lab	weigh boat, 3 1/16" sq.		weigh boat, 3 1/16" sq.	boat
117	117	SAAX 0307	LM	LSF	Life Sciences Lab	saline solution		saline solution	ml
118	118	SAAX 0307	LM	LSF	Life Sciences Lab	anaesthetic		anaesthetic	25 cc
119	119	SAAX 0307	LM	LSF	Life Sciences Lab	serum tubes		serum tubes	30 ml
120	120	SAAX 0307	LM	LSF	Life Sciences Lab	containers (anml. tissue)		containers-anml. tissue	container
121	121	SAAX 0307	LM	LSF	Life Sciences Lab	fixative, animal		fixative, animal	ml
122	122	SAAX 0307	LM	LSF	Life Sciences Lab	containers (plant tissue)		containers-plant tissue	container
123	123	SAAX 0307	LM	LSF	Life Sciences Lab	fixative, plant		fixative, plant	ml
124	124	SAAX 0307	LM	LSF	Life Sciences Lab	plastic bags, small		plastic bags, small	bag
125	125	SAAX 0307	LM	LSF	Life Sciences Lab	plastic bags, large		plastic bags, large	bag
126	126	SAAX 0307	LM	LSF	Life Sciences Lab	vials, spent nutnt, 10 ml		10ml.vials, spent nutnt	vial
127	127	SAAX 0307	LM	LSF	Life Sciences Lab	perfusion fluid		perfusion fluid	ml
128	128	SAAX 0307	LM	LSF	Life Sciences Lab	film packaging		film packaging	TBD
129	129	SAAX 0307	LM	LSF	Life Sciences Lab	Blood Collection Kit	Blood Draws	syringes	syringe
130	130	SAAX 0307	LM	LSF	Life Sciences Lab	Blood Collection Kit	Blood Draws	blood collection tubes	tube
131	131	SAAX 0307	LM	LSF	Life Sciences Lab	Blood Collection Kit	Blood Draws	alcohol pads	pad
132	132	SAAX 0307	LM	LSF	Life Sciences Lab	Blood Collection Kit	Blood Draws	reagent volume	
133	133	SAAX 0307	LM	LSF	Life Sciences Lab	Blood Collection Kit	Blood Draws	general supplies	
134	134	SAAX 0307	LM	LSF	Life Sciences Lab	Blood Collection Kit	Blood Draws	needles	needle
135	135	SAAX 0307	LM	LSF	Life Sciences Lab	Blood Collection Kit	Blood Draws	container	container
136	136	SAAX 0307	LM	LSF	Life Sciences Lab	Echocardiograph	Echo	Echo gel	
137	137	SAAX 0307	LM	LSF	Life Sciences Lab	Echocardiograph	Echo	wet wipes	wipe
138	138	SAAX 0307	LM	LSF	Life Sciences Lab	Echocardiograph	Echo	dry wipes	wipe
139	139	SAAX 0307	LM	LSF	Life Sciences Lab	Electrode Kit	Electrodes	electrodes	pair
140	140	SAAX 0307	LM	LSF	Life Sciences Lab	Electrode Kit	Electrodes	dry wipes	wipe
141	141	SAAX 0307	LM	LSF	Life Sciences Lab	Electrode Kit	Electrodes	alcohol pads	pad
142	142	SAAX 0307	LM	LSF	Life Sciences Lab	Electrode Kit	Electrodes	wet wipes	wipe
143	143	SAAX 0307	LM	LSF	Life Sciences Lab	Electrode Kit	Electrodes	container	container
144	144	SAAX 0307	LM	LSF	Life Sciences Lab	Exercise Equipment	Exercise	electrodes	pair
145	145	SAAX 0307	LM	LSF	Life Sciences Lab	Exercise Equipment	Exercise	dry wipes	wipe
146	146	SAAX 0307	LM	LSF	Life Sciences Lab	Exercise Equipment	Exercise	wet wipes	wipe
147	147	SAAX 0307	LM	LSF	Life Sciences Lab	Microbiologic Lab Cult.	Microbiologic cult.	vials	vial
148	148	SAAX 0307	LM	LSF	Life Sciences Lab	Microbiologic Lab Cult.	Microbiologic cult.	reagent volume	
149	149	SAAX 0307	LM	LSF	Life Sciences Lab	Microbiologic Lab Cult.	Microbiologic cult.	general supplies	
150	150	SAAX 0307	LM	LSF	Life Sciences Lab	RIA Hardware	RIA's	vials	vial
151	151	SAAX 0307	LM	LSF	Life Sciences Lab	RIA Hardware	RIA's	syringes	syringe
152	152	SAAX 0307	LM	LSF	Life Sciences Lab	RIA Hardware	RIA's	reagent volume	
153	153	SAAX 0307	LM	LSF	Life Sciences Lab	RIA Hardware	RIA's	general supplies	

1	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
103	3			200			0.10	5.00									S	B	C. Johnson	ARC
104	3			24			0.01	1.00									S	B	C. Johnson	ARC
105	3			1			0.40	2.00									S	B	C. Johnson	ARC
106	3			500			0.00	0.50									S	B	C. Johnson	ARC
107	3			2			TBD	TBD									S		C. Johnson	ARC
108	3			250			3.20	10.00									S	B	C. Johnson	ARC
109	3			200			1.60	4.00									S	B	C. Johnson	ARC
110	3			5			2.50	12.00									S	B	C. Johnson	ARC
111	3			5			15.00	50.00									S	B	C. Johnson	ARC
112	3			5			0.50	10.00									S	B	C. Johnson	ARC
113	3			180			1.20	10.00									S	B	C. Johnson	ARC
114	3			180			3.60	30.00									S	B	C. Johnson	ARC
115	3			180			1.50	10.00									S	B	C. Johnson	ARC
116	3			400			0.80	3.00									S	B	C. Johnson	ARC
117	3			2000			2.00	2.00									L	B	C. Johnson	ARC
118	3			1			TBD	TBD									L		C. Johnson	ARC
119	3			40			1.60	4.00									S		C. Johnson	ARC
120	3			300			9.90	40.00									S		C. Johnson	ARC
121	3			15000			15.00	TBD									L		C. Johnson	ARC
122	3			35			1.24	15.00									S		C. Johnson	ARC
123	3			5650			5.60	TBD									L		C. Johnson	ARC
124	3			1000			3.00	11.00									S		C. Johnson	ARC
125	3			400			9.00	30.00									S		C. Johnson	ARC
126	3			448			4.00	30.00									S		C. Johnson	ARC
127	3			300			0.30	1.00									L	B	C. Johnson	ARC
128	3			TBD			3.50	31.00									S		C. Johnson	ARC
129	3	6	24	144	0	0.01	0.03	1.44	5	15	10	0	0.4	0.22			S	B	L. Miller	MATSCO
130	3	2.4	24	57.6	0	0.0065	0.01	0.37	3	10	6.5	0	0.4	0.22			S	B	L. Miller	MATSCO
131	3	6	24	144	0	0.003	0.07	0.43	1	5	3	0	1	0.505			S	B,F	L. Miller	MATSCO
132	3	2.4	24	57.6			12.50	12.50									L	T	L. Miller	MATSCO
133	3	6	24	144	0	0.125	1.80	18.00	50	200	125	10	15	12.5			S	B	L. Miller	MATSCO
134	3	6	24	144	0	0.0065	0.03	0.94	3	10	6.5	0	0.4	0.22			S	S	L. Miller	MATSCO
135	3	1	1	1	8.1	27.5	8.10	27.50	25000	30000	27500			8100			S		L. Miller	MATSCO
136	3	2	39	78	0	0.013	0.82	1.01	1	25	13	1	20	10.5			L		L. Miller	MATSCO
137	3	12	39	468	0	0.0325	0.48	15.21	15	50	32.5	0.1	2	1.025			S	B,F	L. Miller	MATSCO
138	3	12	39	468	0	0.0325	0.24	15.21	15	50	32.5	0	1	0.505			S	B,F	L. Miller	MATSCO
139	3	18	6	108	0	0.03	0.59	3.24	10	50	30	1	10	5.5			S	B	L. Miller	MATSCO
140	3	18	6	108	0	0.0325	0.05	3.51	15	50	32.5	0	1	0.505			S	B,F	L. Miller	MATSCO
141	3	18	6	108	0	0.0325	0.11	3.51	15	50	32.5	0.1	2	1.025			S	B,F	L. Miller	MATSCO
142	3	18	6	108	0	0.0325	0.11	3.51	15	50	32.5	0.1	2	1.025			S	B,F	L. Miller	MATSCO
143	3	1	1	1	4.5	17.5	4.50	17.50	10000	25000	17500			4500			S		L. Miller	MATSCO
144	3	18	39	702	0	0.03	7.37	21.06	10	50	30	1	20	10.5			S	B,F	L. Miller	MATSCO
145	3	24	39	936	0	0.0325	0.47	30.42	15	50	32.5	0	1	0.505			S	B,F	L. Miller	MATSCO
146	3	24	39	936	0	0.0325	0.96	30.42	15	50	32.5	0.1	2	1.025			S	B,F	L. Miller	MATSCO
147	3	6	13	78	0	0.0255	1.99	1.99	1	50	25.5	1	50	25.5			S	B	L. Miller	MATSCO
148	3	6	13	78			12.50	12.50									L	B,T	L. Miller	MATSCO
149	3	6	13	78	0	0.2	2.34	15.60	100	300	200	10	50	30			S	B	L. Miller	MATSCO
150	3	6	3	18	0	0.0125	0.14	0.23	5	20	12.5	1	15	8			S	B,R	L. Miller	MATSCO
151	3	6	3	18	0	0.0125	0.00	0.23	5	20	12.5	0	0.5	0.27			S	B,R	L. Miller	MATSCO
152	3	6	3	18	0	0.0275	0.50	0.50	5	50	27.5	5	50	27.5			L	B,R,T	L. Miller	MATSCO
153	3	6	3	18	0	0.13	0.54	2.34	60	200	130	10	50	30			S	B,R	L. Miller	MATSCO

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119	treat as a sample to be returned
120	treat as a sample to be returned
121	treat as a sample to be returned
122	treat as a sample to be returned
123	treat as a sample to be returned
124	treat as a sample to be returned
125	treat as a sample to be returned
126	treat as a sample to be returned
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128	10% 0f mass and vol. of film and video cassettes
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134	S rating in "Code"= Sharp
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154	154	SAAX 0307	LM	LSF	Life Sciences Lab	Urine Collection System	Sampling	dry wipes	wipe
155	155	SAAX 0307	LM	LSF	Life Sciences Lab	Urine Collection System	Sampling	incontinence bags	bag
156	156	SAAX 0307	LM	LSF	Life Sciences Lab	Urine Collection System	Sampling	reagent volume	
157	157	SAAX 0307	LM	LSF	Life Sciences Lab	Urine Collection System	Sampling	general supplies	
158	158	SAAX 0307	LM	LSF	Life Sciences Lab	Urine Collection System	Sampling	wet wipes	wipe
159	159	SAAX 0307	LM	LSF	Life Sciences Lab	Feces Collection System	Sampling	dry wipes	wipe
160	160	SAAX 0307	LM	LSF	Life Sciences Lab	Feces Collection System	Sampling	bolus cups	cup
161	161	SAAX 0307	LM	LSF	Life Sciences Lab	Feces Collection System	Sampling	cup lids	lid
162	162	SAAX 0307	LM	LSF	Life Sciences Lab	Feces Collection System	Sampling	reagent volume	
163	163	SAAX 0307	LM	LSF	Life Sciences Lab	Feces Collection System	Sampling	general supplies	
164	164	SAAX 0307	LM	LSF	Life Sciences Lab	Feces Collection System	Sampling	wet wipes	wipe
165	165	SAAX 0307	LM	LSF	Life Sciences Lab	Containers		containers	container
166	166	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Acoustic Levitator		xenon	1 run
167	167	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Acoustic Levitator		water	1 run
168	168	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Acoustic Levitator		boule fragments	1 run
169	169	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Acoustic Levitator		cleaning fluids	1 run
170	170	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Acoustic Levitator		cooling fluids (He)	1 run
171	171	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Acoustic Levitator		wipes	1 run
172	172	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Acoustic Levitator		gloves	pair
173	173	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Acoustic Levitator		saw blades	blade
174	174	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Acoustic Levitator		melt vapors	1 run
175	175	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		nitrogen	1 run
176	176	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Alloy Solidification		cleaning fluids	1 run
177	177	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Alloy Solidification		cryofluid	1 run
178	178	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Alloy Solidification		selected gases	1 run
179	179	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Alloy Solidification		ampoule fragments	1 run
180	180	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Alloy Solidification		metal particles	1 run
181	181	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Alloy Solidification		wipes	wipe
182	182	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Alloy Solidification		gloves	pair
183	183	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Alloy Solidification		saw blades	blade
184	184	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Alloy Solidification		water	1 run
185	185	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		nitrogen	1 run
186	186	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Autoignition Furnace		selected gas	1 run
187	187	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Autoignition Furnace		cleaning solvents	1 run
188	188	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Autoignition Furnace		water	1 run
189	189	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Autoignition Furnace		combustion products	1 run
190	190	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Autoignition Furnace		gas chromatogr carrier	1 run
191	191	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Autoignition Furnace		wipes	wipe
192	192	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Autoignition Furnace		oxygen	1 run
193	193	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		nitrogen	1 run
194	194	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Cont Flow Electrophoresis		water	1 run
195	195	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Cont Flow Electrophoresis		buffer concentrate	1 run
196	196	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Cont Flow Electrophoresis		culture medium	1 run
197	197	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Cont Flow Electrophoresis		disinfectants	1 run
198	198	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Cont Flow Electrophoresis		raw material	1 run
199	199	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Cont Flow Electrophoresis		staining solution	1 run
200	200	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Cont Flow Electrophoresis		gloves	pair
201	201	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Cont Flow Electrophoresis		test tube	tube
202	202	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Cont Flow Electrophoresis		syringe	syringe
203	203	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Cont Flow Electrophoresis		wipes	wipe
204	204	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Cont Flow Electrophoresis		nitrogen	1 run

OSSA MISSIONS WASTE INVENTORY DATABASE (10/86)

1	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
154	3	6	90	540	0	0.0325	0.27	17.55	15	50	32.5	0	1	0.505			S	B,F	L. Miller	MATSCO
155	3	6	90	540	0	0.04	0.55	21.60	20	60	40	0.1	2	1.025			S	B	L. Miller	MATSCO
156	3	6	90	540			12.50	12.50									L	T	L. Miller	MATSCO
157	3	6	90	540	0	0.8	18.90	432.00	600	1000	800	20	50	35			S	B	L. Miller	MATSCO
158	3	6	90	540	0	0.0325	0.55	17.55	15	50	32.5	0.1	2	1.025			S	B,F	L. Miller	MATSCO
159	3	6	90	540	0	0.0325	0.27	17.55	15	50	32.5	0	1	0.505			S	B,F	L. Miller	MATSCO
160	3	6	90	540	0	0.175	1.62	94.50	100	250	175	1	5	3			S	B	L. Miller	MATSCO
161	3	6	90	540	0	0.0125	0.27	6.75	5	20	12.5	0	1	0.505			S	B	L. Miller	MATSCO
162	3	6	90	540			12.50	12.50									L	T	L. Miller	MATSCO
163	3	6	90	540	0	0.8	18.90	432.00	600	1000	800	20	50	35			S	B	L. Miller	MATSCO
164	3	6	90	540	0	0.0325	0.55	17.55	15	50	32.5	0.1	2	1.025			S	B,F	L. Miller	MATSCO
165	3	1	1	1	5	17.5	5.00	17.50	10000	25000	17500			5000			S		L. Miller	MATSCO
166	3	1	4	4			9.60	1640.00							410	2.4	G		W. Vann	TBE
167	3	1	4	4			8.00	8.00							2	2	L	T	W. Vann	TBE
168	3	1	4	4			0.40	0.24							0.06	0.1	S		W. Vann	TBE
169	3	1	4	4			8.00	8.00							2	2	L	T	W. Vann	TBE
170	3	1	4	4			0.02	88.00							22	0	G		W. Vann	TBE
171	3	10	4	40	0	0.0325	0.02	1.30									S	T	W. Vann	TBE
172	3	2	4	8	0	0.1	0.16	0.80									S	T	W. Vann	TBE
173	3	2	4	8			TBD	TBD							TBD	TBD	S		W. Vann	TBE
174	3	1	4	4			0.10	0.02							0.005	0	G	T	W. Vann	TBE
175	3	1	16	16			3.04	2400.00							150	0.2	G		W. Vann	TBE
176	3	1	3	3			9.90	9.90							3.3	3.3	L	T	W. Vann	TBE
177	3	1	3	3			10.20	7749.99							2583	3.4	G		W. Vann	TBE
178	3	1	3	3			1.50	840.00							280	0.5	G		W. Vann	TBE
179	3	1	3	3			1.71	0.66							0.22	0.6	S		W. Vann	TBE
180	3	1	3	3			1.20	0.21							0.07	0.4	S	T	W. Vann	TBE
181	3	10	3	30	0	0.0325	0.02	0.98									S		W. Vann	TBE
182	3	2	3	6	0	0.1	0.12	0.60									S		W. Vann	TBE
183	3	4	3	12			TBD	TBD							TBD	TBD	S		W. Vann	TBE
184	3	1	3	3			24.00	24.00							8	8	L		W. Vann	TBE
185	3	1	12	12			2.28	1800.00							150	0.2	G		W. Vann	TBE
186	3	1	20	20			60.00	48000							2400	3	G	T	W. Vann	TBE
187	3	1	20	20			1.00	1.00							0.05	0.1	L	T	W. Vann	TBE
188	3	1	20	20			10.00	10.00							0.5	0.5	L	T	W. Vann	TBE
189	3	1	20	20			TBD	TBD							TBD	TBD	S	F,T	W. Vann	TBE
190	3	1	20	20			0.00	2.00							0.1	0	G		W. Vann	TBE
191	3	TBD	20	TBD	0	0.0325	TBD	TBD											W. Vann	TBE
192	3	1	20	20			17.00	12000							600	0.9	G		W. Vann	TBE
193	3	1	20	20			3.80	3000.00							150	0.2	G		W. Vann	TBE
194	3	1	13	13			1820.00	1820.00							140	140	L		W. Vann	TBE
195	3	1	13	13			36.40	36.40							2.8	2.8	L	C	W. Vann	TBE
196	3	1	13	13			2.28	2.28							0.175	0.2	L		W. Vann	TBE
197	3	1	13	13			2.60	2.60							0.2	0.2	L	T	W. Vann	TBE
198	3	1	13	13			0.91	0.91							0.07	0.1	L		W. Vann	TBE
199	3	1	13	13			0.13	0.13							0.01	0	L		W. Vann	TBE
200	3	1	13	13	0	0.1	0.26	1.30									S		W. Vann	TBE
201	3	4	13	52			0.00	0.00									S		W. Vann	TBE
202	3	5	13	65	0	0.0625	0.65	4.06									S		W. Vann	TBE
203	3	10	13	130	0	0.0325	0.07	4.23									S		W. Vann	TBE
204	3	1	26	26			4.94	3900.00							150	0.2	G		W. Vann	TBE

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166	Other candidate gases are air, Ar, He
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170	STP
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175	
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177	Helium or nitrogen
178	Air, Ar, N2, He
179	
180	
181	
182	
183	
184	
185	STP
186	Ar or He or N2
187	
188	
189	
190	N2 or He
191	
192	STP
193	STP
194	
195	
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197	Sodium azide or gluderaldehyde
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204	STP

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205	205	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Critical Point Phenomena		gaseous helium	1 run
206	206	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Critical Point Phenomena		gaseous nitrogen	1 run
207	207	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Critical Point Phenomena		helium (cooling)	1 run
208	208	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Critical Point Phenomena		nitrogen (cooling)	1 run
209	209	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Critical Point Phenomena		cleaning solution	1 run
210	210	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Critical Point Phenomena		sample material	1 run
211	211	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Critical Point Phenomena		wipes	wipe
212	212	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Critical Point Phenomena		gloves	pair
213	213	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Critical Point Phenomena		teflon O-rings	O-ring
214	214	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Electroepitaxy		hydrogen	1 run
215	215	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Electroepitaxy		nitrogen	1 run
216	216	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Electroepitaxy		arsenic	1 run
217	217	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Electroepitaxy		boule fragments	1 run
218	218	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Electroepitaxy		lab clothing etc.	1 run
219	219	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Electroepitaxy		etchants	1 run
220	220	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Electroepitaxy		gallium arsenide	1 run
221	221	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Electroepitaxy		gallium	1 run
222	222	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Electroepitaxy		polishing solution	1 run
223	223	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		nitrogen	1 run
224	224	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Fluid Physics		cleaning solution	1 run
225	225	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Fluid Physics		water	1 run
226	226	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Fluid Physics		nitrogen	1 run
227	227	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Fluid Physics		solvents	1 run
228	228	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Fluid Physics		TGS solution	1 run
229	229	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Fluid Physics		cutting/polishing fluid	1 run
230	230	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Fluid Physics		xray film developer	1 run
231	231	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Fluid Physics		xray film fixer	1 run
232	232	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		nitrogen	1 run
233	233	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Gas Containers		gas containers	TBD
234	234	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		filters	TBD
235	235	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		gloves from box	TBD
236	236	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		cleaning solutions	TBD
237	237	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		seals for box	TBD
238	238	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		water	TBD
239	239	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		wipes	TBD
240	240	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		disinfectants	TBD
241	241	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Latex Reactor		cleaning fluids	1 run
242	242	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Latex Reactor		initiator (AMBN)	1 run
243	243	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Latex Reactor		latex solutions	1 run
244	244	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Latex Reactor		product spheres	1 run
245	245	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Latex Reactor		styrene	1 run
246	246	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Latex Reactor		wipes	wipe
247	247	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Latex Reactor		gloves	pair
248	248	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Latex Reactor		syringes	syringe
249	249	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		nitrogen	1 run
250	250	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Membrane Production		cleaning fluids	1 run
251	251	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Membrane Production		water	1 run
252	252	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Membrane Production		nitrogen	1 run
253	253	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Membrane Production		catalyst solutions	1 run
254	254	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Membrane Production		monomer solutions	1 run
255	255	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Membrane Production		wipes	wipe

1	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
205	3	1	6	6			0.22	1200.00							200	0	G		W. Vann	TBE
206	3	1	6	6			1.50	1200.00							200	0.3	G		W. Vann	TBE
207	3	1	6	6			21.96	123000							20500	3.7	G		W. Vann	TBE
208	3	1	6	6			145.80	117000							19500	24	G		W. Vann	TBE
209	3	1	6	6			0.06	0.06							0.01	0	L	T	W. Vann	TBE
210	3	1	6	6			10.56	3.00							0.5	1.8	L	T	W. Vann	TBE
211	3	5	6	30	0	0.0325	0.02	0.98									S	T	W. Vann	TBE
212	3	2	6	12	0	0.1	0.24	1.20									S	T	W. Vann	TBE
213	3	2	6	12			TBD	TBD							TBD	TBD	S		W. Vann	TBE
214	3	1	7	7			0.32	3500.00							500	0	G	F	W. Vann	TBE
215	3	1	7	7			4.41	3500.00							500	0.6	G		W. Vann	TBE
216	3	1	7	7			0.70	0.70							0.1	0.1	G	T	W. Vann	TBE
217	3	1	7	7			0.17	0.14							0.02	0	S	T	W. Vann	TBE
218	3	1	7	7			7.00	294.00							42	1	S	T	W. Vann	TBE
219	3	1	7	7			0.00	0.00							5E-04	0	L	T	W. Vann	TBE
220	3	1	7	7			0.88	0.88							0.125	0.1	S	T	W. Vann	TBE
221	3	1	7	7			0.35	0.70							0.1	0.1	G	T	W. Vann	TBE
222	3	1	7	7			7.00	7.00							1	1	L	C,F,T	W. Vann	TBE
223	3	1	28	28			5.32	4200.00							150	0.2	G		W. Vann	TBE
224	3	1	6	6			0.60	0.60							0.1	0.1	L	T	W. Vann	TBE
225	3	1	6	6			138.00	138.00							23	23	L	T	W. Vann	TBE
226	3	1	6	6			2.70	2160.00							360	0.5	G		W. Vann	TBE
227	3	1	6	6			1.50	1.50							0.25	0.3	L	F,T	W. Vann	TBE
228	3	1	6	6			3.00	3.00							0.5	0.5	L		W. Vann	TBE
229	3	1	6	6			6.00	6.00							1	1	L	T	W. Vann	TBE
230	3	1	6	6			TBD	TBD							TBD	TBD	L	T	W. Vann	TBE
231	3	1	6	6			TBD	TBD							TBD	TBD	L	T	W. Vann	TBE
232	3	1	18	18			3.42	2700.00							150	0.2	G		W. Vann	TBE
233	3			TBD			413.00	2190.00									S		W. Vann	TBE
234	3			TBD			TBD	TBD									S		W. Vann	TBE
235	3			TBD			TBD	TBD									S		W. Vann	TBE
236	3			TBD			TBD	TBD									L		W. Vann	TBE
237	3			TBD			TBD	TBD									S		W. Vann	TBE
238	3			TBD			TBD	TBD									L		W. Vann	TBE
239	3			TBD	0	0.0325	TBD	TBD									S		W. Vann	TBE
240	3			TBD			TBD	TBD									L		W. Vann	TBE
241	3	1	6	6			0.06	0.06							0.01	0	L	F,T	W. Vann	TBE
242	3	1	6	6			0.01	0.01							0.001	0	S	F,T	W. Vann	TBE
243	3	1	6	6			0.01	0.01							0.001	0	L		W. Vann	TBE
244	3	1	6	6			0.00	0.00							1E-04	0	S	F	W. Vann	TBE
245	3	1	6	6			0.01	0.01							0.001	0	L	F,T	W. Vann	TBE
246	3	1	6	6	0	0.0325	0.00	0.20									S		W. Vann	TBE
247	3	1	6	6	0	0.1	0.12	0.60									S		W. Vann	TBE
248	3	4	6	24	0	0.0625	0.24	1.50									S		W. Vann	TBE
249	3	1	12	12			2.28	1800.00							150	0.2	G		W. Vann	TBE
250	3	1	5	5			1.25	1.25							0.25	0.3	L	T	W. Vann	TBE
251	3	1	5	5			2.50	2.50							0.5	0.5	L	T	W. Vann	TBE
252	3	1	5	5			1.75	1400.00							280	0.4	G		W. Vann	TBE
253	3	1	5	5			0.01	0.01							0.001	0	G	F	W. Vann	TBE
254	3	1	5	5			0.01	0.01							0.001	0	L	F,T	W. Vann	TBE
255	3	5	5	25	0	0.0325	0.01	0.81									S	T	W. Vann	TBE

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205	
206	
207	
208	wt. based on spec. gravity = .808
209	
210	Low boiling point fluid (Xe, Ar)
211	
212	
213	
214	STP
215	STP
216	
217	
218	
219	
220	
221	
222	
223	
224	
225	
226	STP
227	
228	
229	
230	
231	
232	
233	based on dewars for liq./other gases @ 1200 psi for transport
234	2 glovebox types requested: Fluids/class 100; particulate
235	2 glovebox types requested: Fluids/class 100; particulate
236	2 glovebox types requested: Fluids/class 100; particulate
237	2 glovebox types requested: Fluids/class 100; particulate
238	2 glovebox types requested: Fluids/class 100; particulate
239	2 glovebox types requested: Fluids/class 100; particulate
240	2 glovebox types requested: Fluids/class 100; particulate
241	
242	
243	
244	
245	
246	
247	
248	
249	STP
250	
251	
252	STP
253	
254	
255	

1	1	2	3	4	5	6	7	8	9
256	256	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Membrane Production		gloves	glove
257	257	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Membrane Production		syringes	syringe
258	258	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		nitrogen	1 run
259	259	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Org and Poly Crys Growth		cleaning fluids	1 run
260	260	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Org and Poly Crys Growth		water	1 run
261	261	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Org and Poly Crys Growth		selected gas	1 run
262	262	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Org and Poly Crys Growth		oxygen	1 run
263	263	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Org and Poly Crys Growth		solvents	1 run
264	264	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Org and Poly Crys Growth		melt vapors	1 run
265	265	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Org and Poly Crys Growth		wipes	wipe
266	266	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Org and Poly Crys Growth		gloves	pair
267	267	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Org and Poly Crys Growth		nitrogen	1 run
268	268	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Protein Crystal Growth		water	1 run
269	269	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Protein Crystal Growth		nitrogen	1 run
270	270	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Protein Crystal Growth		argon	1 run
271	271	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Protein Crystal Growth		oxygen	1 run
272	272	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Protein Crystal Growth		disinfectants	1 run
273	273	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Protein Crystal Growth		raw protein solution	1 run
274	274	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Protein Crystal Growth		high vacuum wax	1 run
275	275	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Protein Crystal Growth		wipes	1 run
276	276	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Protein Crystal Growth		syringes	1 run
277	277	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		nitrogen	1 run
278	278	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Rotating Spherical Conv.		water	1 run
279	279	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Rotating Spherical Conv.		cleaning fluid solution	1 run
280	280	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Rotating Spherical Conv.		gloves	pair
281	281	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Rotating Spherical Conv.		wipes	wipe
282	282	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Small Bridgman		argon	1 run
283	283	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Small Bridgman		water	1 run
284	284	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Small Bridgman		boule fragments	1 run
285	285	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Small Bridgman		ampoule fragments	1 run
286	286	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Small Bridgman		etchants	1 run
287	287	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Small Bridgman		cutting/polishing fluid	1 run
288	288	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Small Bridgman		wipes	wipe
289	289	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Small Bridgman		gloves	pair
290	290	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Small Bridgman		saw blades	blade
291	291	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		nitrogen	1 run
292	292	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Solution Crystal		water	1 run
293	293	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Solution Crystal		nitrogen	1 run
294	294	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Solution Crystal		sodium aluminate	1 run
295	295	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Solution Crystal		sodium chlorate	1 run
296	296	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Solution Crystal		sodium hydroxide	1 run
297	297	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Solution Crystal		cleaning solutions	1 run
298	298	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Solution Crystal		solvents	1 run
299	299	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Solution Crystal		TGS solution	1 run
300	300	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Solution Crystal		cutting/polishing fluid	1 run
301	301	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Solution Crystal		xray film developer	1 run
302	302	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Solution Crystal		xray film fixer	1 run
303	303	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Solution Crystal		sodium metasilicate	1 run
304	304	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		nitrogen	1 run
305	305	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Vapor Crystal		argon	1 run
306	306	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Vapor Crystal		air	1 run

1	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
256	3	2	5	10	0	0.1	0.20	1.00									S	T	W. Vann	TBE
257	3	10	5	50	0	0.0625	0.50	3.13									S		W. Vann	TBE
258	3	1	5	5			0.95	750.00							150	0.2	G		W. Vann	TBE
259	3	1	13	13			0.13	0.13							0.01	0	L	T	W. Vann	TBE
260	3	1	13	13			52.00	52.00							4	4	L	T	W. Vann	TBE
261	3	1	13	13			7.67	3900.00							300	0.6	G		W. Vann	TBE
262	3	1	13	13			5.20	3640.00							280	0.4	G		W. Vann	TBE
263	3	1	13	13			26.00	26.00							2	2	L	F,T	W. Vann	TBE
264	3	1	13	13			0.00	0.01							0.001	0	G	F,T	W. Vann	TBE
265	3	3	13	39	0	0.0325	0.02	1.27									S	T	W. Vann	TBE
266	3	2	13	26	0	0.1	0.52	2.60									S	T	W. Vann	TBE
267	3	1	13	13			2.47	1950.00							150	0.2	G		W. Vann	TBE
268	3	1	7	7			4.90	4.90							0.7	0.7	L	T	W. Vann	TBE
269	3	1	7	7			3.15	2520.00							360	0.5	G		W. Vann	TBE
270	3	1	7	7			4.48	2508.00							36	0.6	G		W. Vann	TBE
271	3	1	7	7			0.36	252.00							36	0.1	G		W. Vann	TBE
272	3	1	7	7			0.35	0.35							0.05	0.1	L	C,T	W. Vann	TBE
273	3	1	7	7			35.00	35.00							5	5	L		W. Vann	TBE
274	3	1	7	7			0.02	0.21							0.03	0	S	F	W. Vann	TBE
275	3	10	7	70	0	0.0325	0.04	2.28									S	F,T	W. Vann	TBE
276	3	100	7	700	0	0.0625	7.00	43.75			5						S	T	W. Vann	TBE
277	3	1	21	21			3.99	3150.00							150	0.2	G		W. Vann	TBE
278	3	1	4	4			0.40	0.40							0.1	0.1	L	T	W. Vann	TBE
279	3	1	4	4			2.00	2.00							0.5	0.5	L		W. Vann	TBE
280	3	1	4	4	0	0.1	0.08	0.40									S		W. Vann	TBE
281	3	10	4	40	0	0.0325	0.02	1.30									S		W. Vann	TBE
282	3	1	5	5			1.60	875.00							175	0.3	G		W. Vann	TBE
283	3	1	5	5			10.50	10.50							2.1	2.1	L	T	W. Vann	TBE
284	3	1	5	5			0.85	0.15							0.03	0.2	S	F,T	W. Vann	TBE
285	3	1	5	5			1.15	0.45							0.09	0.2	S		W. Vann	TBE
286	3	1	5	5			0.03	0.03							0.005	0	L	T	W. Vann	TBE
287	3	1	5	5			2.50	2.50							0.5	0.5	L	T	W. Vann	TBE
288	3	10	5	50	0	0.0325	0.03	1.63									S	T	W. Vann	TBE
289	3	2	5	10	0	0.1	0.20	1.00									S	T	W. Vann	TBE
290	3	4	5	20			TBD	TBD							TBD	TBD	S	T	W. Vann	TBE
291	3	1	20	20			3.80	3000.00							150	0.2	G		W. Vann	TBE
292	3	1	13	13			230.10	230.10							17.7	18	L	T	W. Vann	TBE
293	3	1	13	13			5.85	4693.00							361	0.5	G		W. Vann	TBE
294	3	1	13	13			11.96	11.96							0.92	0.9	L	T	W. Vann	TBE
295	3	1	13	13			5.07	5.07							0.39	0.4	L	T	W. Vann	TBE
296	3	1	13	13			1.95	1.95							0.15	0.2	L	T	W. Vann	TBE
297	3	1	13	13			26.00	26.00							2	2	L	T	W. Vann	TBE
298	3	1	13	13			3.25	3.25							0.25	0.3	L	F,T	W. Vann	TBE
299	3	1	13	13			6.50	6.50							0.5	0.5	L		W. Vann	TBE
300	3	1	13	13			13.00	13.00							1	1	L		W. Vann	TBE
301	3	1	13	13			TBD	TBD							TBD	TBD	L	T	W. Vann	TBE
302	3	1	13	13			TBD	TBD							TBD	TBD	L	T	W. Vann	TBE
303	3	1	13	13			TBD	TBD									S		W. Vann	TBE
304	3	1	39	39			7.41	5850.00							150	0.2	G		W. Vann	TBE
305	3	1	10	10			2.90	1600.00							160	0.3	G		W. Vann	TBE
306	3	1	10	10			5.60	4480.00							448	0.6	G		W. Vann	TBE

1	30
256	
257	
258	STP
259	
260	
261	CO2 or N2 at STP
262	STP
263	
264	
265	
266	
267	STP
268	
269	STP
270	STP
271	STP
272	Sodium azide
273	Varies 5 ml per syringe 100-1000 syringes
274	Wax to close 10-100 tubes
275	
276	
277	STP
278	Interest decreasing in Facility
279	Interest decreasing in Facility
280	
281	
282	STP
283	
284	Fragments, maybe Hg, Cd, Te (alloys)
285	
286	
287	
288	
289	
290	
291	STP
292	
293	STP
294	
295	
296	
297	
298	
299	
300	
301	
302	
303	
304	STP
305	STP
306	STP

1	1	2	3	4	5	6	7	8	9
307	307	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Vapor Crystal		cleaning fluid	1 run
308	308	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Vapor Crystal		ampoule fragments	1 run
309	309	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Vapor Crystal		etchants solution	1 run
310	310	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Vapor Crystal		polishing solutions	1 run
311	311	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Vapor Crystal		transport agent	1 run
312	312	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Vapor Crystal		boule fragments	1 run
313	313	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Vapor Crystal		wipes	wipe
314	314	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Vapor Crystal		gloves	pair
315	315	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Vapor Crystal		saw blades	blade
316	316	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Vapor Crystal		seals for modules	seal
317	317	SAAX 0401	LM	MMPF	Microgravity Materials Processing Facility	Glovebox		nitrogen	1 run
318	318	SAAX 0502	P/L	SBAR	Space-Based Antenna Test Range			propellant (type TBD)	

1	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
307	3	1	10	10			40.00	40.00							4	4	L		W. Vann	TBE
308	3	1	10	10			7.20	2.80							0.28	0.7	S		W. Vann	TBE
309	3	1	10	10			0.40	0.40							0.04	0	L	C,T	W. Vann	TBE
310	3	1	10	10			40.00	40.00							4	4	L	F,T	W. Vann	TBE
311	3	1	10	10			2.90	200.00							20	0.3	G	T	W. Vann	TBE
312	3	1	10	10			35.00	3.50							0.35	3.5	S	T	W. Vann	TBE
313	3	10	10	100	0	0.0325	0.05	3.25									S		W. Vann	TBE
314	3	2	10	20	0	0.1	0.40	2.00									S		W. Vann	TBE
315	3	2	10	20			TBD	TBD							TBD	TBD	S		W. Vann	TBE
316	3	4	10	40			TBD	TBD							TBD	TBD	S		W. Vann	TBE
317	3	1	20	20			3.80	3000.00							150	0.2	G		W. Vann	TBE
318	1			TBD			TBD	TBD									TBD		T. Campbell	LaRC

1	30
307	
308	Quartz tube
309	
310	
311	Possible gases: Hg, I, H, Cl, Br, O, N, S, C
312	Possible materials are: Cd, Ga, As, Hg, Te, Pb, Zn, S, Sn, I, Se
313	
314	
315	
316	
317	STP
318	This mission not yet funded

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APPENDIX A-5. ACRONYM GLOSSARY

ACM	Attitude Control Module
ACRIM	Active Cavity Radiometer Irradiance Monitor
ACS	Attitude Control Subsystem
AEPI	Atmospheric Emission Photometric Imaging
ARC	NASA Ames Research Center, Moffett Field, CA
ASO/HRSO	Advanced Solar Observatory: High Resolution Solar Observatory
ASO/POF	Advanced Solar Observatory: Pinhole/Occulter Facility
AT	Astrometric Telescope — Extrasolar
AVHRR	Advanced Very High Resolution Radiometer
AXAF	Advanced X-ray Astronomy Facility
BATSE	Burst and Transient Source Explosion
BDM	BDM Corporation
C&DH	Communications and Data Handling Module
CDCE	Cosmic Dust Collection Experiment
CRNE	Cosmic Ray Nuclei Experiment
DMS	Data Management System
ERBE	Earth Radiation Budget Experiment (also known as HH4)
ESMR	Electrically Scanned Microwave Radiometer
EVA	extra-vehicular activity
EX1	Explorer 1 (Solar Maximum Mission) Servicing
EX2	Explorer 2 Servicing
EX3	Explorer 3 Servicing
GRO	Gamma Ray Observatory
GSFC	NASA Goddard Space Flight Center, Greenbelt, MD
HGA	High Gain Antenna
HH1	Space Station Hitchhiker 1
HH2	Space Station Hitchhiker 2
HH3	Space Station Hitchhiker 3
HH4	Space Station Hitchhiker 4 (also known as ERBE)
HQ	NASA Headquarters, Washington, DC
HRSO	High Resolution Solar Telescope
HRTS	Solar UV High Resolution Telescope and Spectrograph
HST	Hubble Space Telescope
IOC	Initial Operational Capability
IVA	intra-vehicular activity

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JPL	Jet Propulsion Laboratory, Pasadena, CA
JSC	NASA Johnson Space Center, Houston, TX
LaRC	NASA Langley Research Center, Hampton, VA
LSL	Life Sciences Lab
MMPF	Microgravity and Materials Processing Facility
MMS	Multimission Modular Spacecraft
MPS	Modular Power Subsystem
MRDB	Mission Requirements Database
MRMS	Mobile Remote Manipulator System
MSFC	NASA George C. Marshall Space Flight Center, AL
OMV	Orbital Maneuvering Vehicle
OSCAR	Orbital Spacecraft Consumables Resupply System
OSSA	Office of Space Science and Applications
OSU	orbital servicing unit
P/L	payload
RIA	radioimmunology assays
RPDP	Recoverable Plasma Diagonstic Package
SA	Solar Array
SAAX	prefix code for OSSA mission number
SAIC	Science Applications International Corporation
SBAR	Space-Based Antenna Test Range
SEPAC	Space Experiments with Particle Accelerators
SI	service interval
SIRTF	Space Infrared Telescope Facility
SMF	Superconducting Magnet Facility
SOT	Solar Optical Telescope
SPS	NASA code for ARC Space Station Projects Office
SS	Space Station
SSS	Space Station Spartan
STO	Solar Terrestrial Observatory
STP	Standard Temperature and Pressure (0 °C and 1 atm.)
STS	Space Transportation System ("Shuttle")
SUSIM	Solar UV Spectral Irradiance Monitor
TBE	Teledyne Brown Engineering, Huntsville, AL
TEBPP	Theoretical and Experimental Beam Plasma Physics
TRMM	Tropical Rainfall Mapping Mission
WISP	Waves in Space Plasma
XRP	X-ray Polarimeter